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FREDERICK J. H. MERRILL Director
EPHRAIM PORTER FELT State Entomologist

Bulletin 53

ENTOMOLOGY 14

17th Report of the State Entomologist

ON

INJURIOUS AND OTHER INSECTS

OF THE

STATE OF NEW YORK

1901

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New York State Museum

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Bulletin 53

17TH REPORT OF THE STATE ENTOMOLOGIST

1901

To the Regents of the University of the State of New York

I have the honor of presenting herewith my report on the injurious and other insects of the state of New York for the year ending Oct. 15, 1901.

General entomologic features. The forest tent-caterpillar, Clisiocampa disstria Hübn., as was predicted last year, has, generally speaking, not been nearly so injurious the last season, though in places here and there in the state, it has inflicted considerable damage. Its abundance in orchards adjacent to woods badly infested the previous year was a somewhat characteristic feature of the attack this season. The common apple-tree tent-caterpillar, Clisiocampa americana Fabr., has also been abundant in different sections of the state, but it has not been specially injurious as a rule. The white marked tussock moth, Notolophus leucostigma Abb. & Sm., has been quite harmful to the shade trees of Buffalo. The destructive work of the elm leaf beetle, Galerucella luteola Müll., has been continued in the Hudson river valley, and in its northern part this insect has succeeded in extending its range to a number of villages previously infested with very few or none of these pests. The fall web worm, Hyphantria cunea Drury, has been exceedingly abundant in portions of the southern part of the valley and near the western end of Long Island. The depredations of the Hessian fly, Cecidomyia

destructor Say, were so general and so severe as to inflict enormous damages, they having been estimated by competent parties as high as $3,000,000. A very serious matter has been the discovery that the notorious gipsy moth, Porthetria dispar Linn., has become well established in the city of Providence R. I. Investigations made during the summer show that the pest already occupies a considerable area in and about that city. While this spread has not been directly toward New York state, it may well be regarded as a warning of what may occur within a few years, and residents of the state are advised to keep a sharp lookout for the advent of this very destructive insect.

Office work. There has been no relaxation in the pressure of office work, and, though there has been an apparent decrease in the amount of correspondence, all of the office staff have been obliged to work overtime in order to meet the demands of the situation. The determination of scale insects for the state department of agriculture still makes considerable inroads on our time. Most of this important and very difficult work has fallen on my first assistant, Miss Boynton. On the request of the commissioner of agriculture, made necessary by the position of the state entomologist of Virginia, who refused to accept any certificate unless it was vouched for by an official entomologist, a general statement was issued approving the work of his inspectors. The time of the office force has been occupied to a considerable extent by the reading of proof and verification incident to the carrying through the press of two very important bulletins soon to be issued, one on the important scale insects of the state and the other on aquatic insects of the Adirondack region. A number of excellent lantern slides have been purchased, and some made from original photographs. These form a nucleus of what will soon become an excellent collection for use in illustrated lectures. The new cards for recording accessions to the entomologic collections have proved very satisfactory, resulting in a great saving of time. 954 letters, 295 postals and 693 packages were sent through the mails during the year.

There has been an unavoidable break in the office caused by the resignation of my first assistant, Mr C. S. Banks, who severed his connection with the office July 15, a particularly unfortunate time, since it is the season when insect activities are at their hight. Miss Margaret F. Boynton was promoted to the position of first assistant, and Mr C. M. Walker, who has been an advanced student in entomology for nearly two years under Prof. C. H. Fernald of the Massachusetts agricultural college and who was the special assistant in the preparation of the collection for exhibition at the Pan-American exposition, was appointed second assistant.

Special investigations. Three lines of work mentioned in my previous report have been prosecuted during the past season.

1 The series of experiments with insecticides for the control of the San José scale have been carried on in the same orchard as last year, and the results obtained in 1900 have been largely confirmed. Fuller details of this work will be found on subsequent pages.

2 The study of forest and shade tree insects has been continued, and many of the observations of previous years have been prepared for publication, and those of this season will be put in a similar condition as soon as possible.

3 The special study of aquatic insects, begun in 1900 has also been continued. It is noticed in the following paragraph.

Entomologic field station. The work commenced at Saranac Inn in 1900 was continued at Ithaca N. Y. in cooperation with the Cornell university authorities. Dr James G. Needham of Lake Forest university, Lake Forest Ill. was in charge of the work, as last year. It was largely supplemental to the studies of the previous season, and Dr Needham's report will therefore include a rather full account of the damsel flies, Odonata-Zygoptera, and of the fish food material collected by him at Saranac Inn. A family of small flies (Chironomidae), very important so far as fish food is concerned, has received special study by Mr O. A. Johannsen, an advanced student at Cornell university, and his account will also be included in this report.

Publications. The principal publications of the entomologist, to the number of 62, are listed under the usual heading. The most important of these is the 16th report. Owing to the delay incident to printing, three very important publications have not appeared during the past year, though they are practically ready to be issued. They are: Museum bulletin 46, *Scale insects of importance and list of the species in New York state*, Museum bulletin 47, *Aquatic insects in the Adirondacks* (Dr Needham's report for 1900), and the special paper treating of insects injurious to elm trees. The last is to appear in the 5th report of the fisheries, game and forest commissioners of New York state. These three publications are admirably illustrated by a series of colored plates.

Extension work. Considerable of the time of the entomologist and his former first assistant, Mr C. S. Banks, was occupied by farmers institutes. They covered a period of 23 working days, during which lectures were delivered at the following 14 places: Preston Hollow, Durham, Hensonville, Lexington, Fleischmanns, Halcottsville, Grand Gorge, Walton, Gilbertsville, South New Berlin, New Berlin, Russia, Newport and Frankfort. An important paper was read by the entomologist before the Massachusetts fruit growers association at a meeting held last March at Worcester Mass., and several addresses have also been given by him before various scientific and horticultural organizations.

Collection of insects. The additions to the state collection of insects have been very great. They may be estimated at approximately 16,000 pinned, labeled specimens, besides a great many in alcohol. A special effort has been made to secure desirable biologic material. My former assistant, Mr Banks, and my present assistant, Miss Boynton, have spent a great deal of time during the past year in going over the collection and classifying the insects more thoroughly. Most of the state collection has now been referred to families, and considerable work has been done on beetles (Coleoptera), the scale insects (Coccidae), and the grasshoppers (Orthoptera). The work on the two latter

orders was done entirely by Miss Boynton. Most of that on the Coleoptera was done by Mr Banks, though Mr Walker has given some time to this order in the past few months. An immense amount of work is still necessary before the collection will be in a thoroughly satisfactory condition.

The office has been very fortunate in retaining the entomologic library and collection of the late Dr J. A. Lintner. These collections are not only of great value in a scientific way but they are almost indispensable aids in conducting the work of the department. It is very gratifying that they should be placed where they will receive the best of care, and surely no place is quite so appropriate as the institution where Dr Lintner did most of his scientific work.

Pan-American collection. The preparation of an exhibit for the Pan-American exposition at Buffalo involved much work on the part of the regular office force in addition to that performed by a special assistant, Mr C. M. Walker, who was engaged for three months. It was felt that, since an exhibit was to be prepared, it should be put in first class shape, and so far as possible this was done. One gold and three silver medals were awarded the exhibit. A brief account of this collection together with a catalogue is appended to this report.

New quarters. The removal of the office from the old quarters in the capitol to Geological and agricultural hall has been a great advantage, since it gave not only much needed space but also essential facilities. The floor space of the general office and the amount of shelving have been much increased by the change, but there is still none too much room. The admirably equipped dark room in the general office supplies a much needed want, as it permits the photographing of insects and their work in a minimum amount of time. The space outside of the general office affords an excellent opportunity for the display of insects and their work in a place readily accessible to the public. Several special collections have already been prepared and placed on exhibition, and it is proposed to give considerable prominence in the display collection to the injurious and bene-

ficial forms. The large one now at the Pan-American exposition will also be placed on exhibition as soon as it is returned.

Voluntary observers. Most of the persons cooperating with the office in 1899 and 1900 in this capacity have continued to render substantial aid this season. Their number has naturally decreased somewhat, and, on account of the pressure of work in early spring, due to the preparation of the exhibit at Buffalo, there was little opportunity to strengthen their ranks. Many valuable observations were made, and summaries of the reports will be found on p. 776–800.

Acknowledgments. The entomologist is under obligations to other workers along the same lines. To Dr L. O. Howard, chief of the division of entomology of the United States department of agriculture, and his staff, special acknowledgments are due for the determination of a great many insects and for promptly placing information at my disposal. Prof. J. H. Comstock of Cornell university deserves special mention for so kindly placing the facilities of his department at the service of the entomologic field station, and for giving the work such hearty support.

It is a pleasure to acknowledge the continued support and encouragement given by the regents during the past year. The work has necessarily been somewhat hampered by the moving into new quarters and by unforeseen changes in the staff, but the outlook for the future is most auspicious.

Respectfully submitted

EPHRAIM PORTER FELT

State entomologist

Office of the state entomologist

Albany 15 Oct. 1901

INJURIOUS INSECTS

Cecidomyia destructor Say

HESSIAN FLY

Ord. *Diptera;* Fam. *Cecidomyiidae*

This species was first observed in this country in New York and its common name was bestowed in the belief that it came to us in packing or straw shipped to the Hessian soldiers then stationed on Long Island. The probabilities tend in that direction though absolute proof may always be wanting. This pest attracted the attention of entomologists in the early part of the last century on account of its serious injuries, as it gradually spread over the country. Dr Asa Fitch, entomologist of the New York state agricultural society was one of the first to give a detailed account of it and much that he published can not be bettered in this later day. His account is now almost inaccessible to the general public and though the pest has been treated in some detail by later writers, particularly by Prof. Webster and Prof. Osborn, there is no complete recent account of it as it occurs in New York. A very good general account of the insect in the United States is given by Prof. Osborn in Bulletin 16, new series, division of entomology, United States department of agriculture.

Early injuries in New York by the Hessian fly. This summary account of the depredations of the pest is taken largely from the quite full treatise on it given by Dr Packard in the 3d report of the United States entomological commission.

The Hessian fly first became a serious pest in 1779 at which time and for several succeeding years wheat was severely injured or wholly destroyed by it in Kings and Richmond counties. In 1786 and 1787, its ravages again attracted considerable attention in this state, the crop of eastern Long Island having been almost universally destroyed. In 1803 very severe losses were caused by its operations in Saratoga and Washington counties and on two or three occasions in earlier years many of the fields in Saratoga county were entirely destroyed. Again in 1844 losses occasioned by it on Long Island and at Rochester

were very severe. Throughout the state of New York it was exceedingly destructive in 1846. In the western section it was estimated to have caused a loss of not less than 500,000 bushels. It was also very injurious in some counties in New York and in Ohio in 1849. It was exceedingly destructive about Syracuse in 1876, whole fields and parts of others turning yellow and showing the ravages of the fly to a greater extent than had ever been witnessed, and in 1877 and 1878 white wheats were severely damaged, the presence of the Hessian fly in Cayuga, Seneca, Tompkins and Yates counties being specifically recorded. There was some injury in Tioga county in 1881 and very slight damage was reported in 1882 from Columbia, Genesee, Herkimer, Monroe, Niagara, Yates and Wyoming counties, it being more serious in the latter. Dr Lintner, in his 5th report, p.263, states that this insect caused more injury than usual in western New York in 1884.

Recent injuries in western New York. The following records were taken largely from reports of voluntary observers.

1899. The Hessian fly has done much damage in the wheat fields in and about East Amherst, Erie co. In my own fields one fifth of the wheat is down. This was sown on Sep. 9, 1899. Some fields that were sown in August are from one half to nine tenths down. All wheat fields in this vicinity are damaged more or less. Even those that were sown the latter part of September or in early October are infested to some extent. (John U. Metz)

The Hessian fly is doing considerable damage in and about Belle Isle, Onondaga co. (Mrs. A. M. Armstrong)

The Hessian fly has seriously injured early sown wheat all through Seneca county. Some pieces are very seriously damaged while others are comparatively free from the pest. It is estimated that about one fourth of the crop has been lost through the attacks of this insect. (J. F. Hunt, Kendaia)

I noticed very bad work indeed in this section from the Hessian fly. A great amount of wheat is down. Perhaps one third of the straw is lodged and the damage will be one fourth of the entire yield. (C. H. Stuart, Newark, Wayne co.)

1900. The Hessian fly is in the vicinity of East Amherst in great numbers and the white wheat throughout this section is nearly all down flat. One field of 8 acres in this vicinity is almost totally destroyed. It was sown August 27. (John U. Metz, Erie co.)

The wheat in the vicinity of Warner, Onondaga co. was damaged more than last season. Fully one third of it lodged and the injury is more general than last year. I have found the flies in late sown wheat. One piece sown September 10 was very thoroughly infested, not a single plant being free from the pest. (Mrs A. M. A. Jackson)

The Hessian fly has done a great deal of damage to some pieces in this section of the country. (J. F. Hunt, Kendaia, Seneca co.)

The Hessian fly has been very bad in some wheat, some pieces being so very severely injured that they have not been harvested. (C. E. Chapman, Peruville, Tompkins co.)

The Hessian fly has been working very badly indeed in early sown wheat. The later sowings are not nearly so badly infested. Perhaps one fourth of the entire crop has been destroyed. (C. H. Stuart, Newark, Wayne co.)

1901. Damage from Hessian fly work is very evident in several pieces of wheat examined. Probably 10% of the stalks have lodged as a result of the work of this fly. (M. H. Beckwith, Elmira, Chemung co.)

Mr M. F. Adams of Buffalo, after making an examination of a number of fields in the vicinity of that city finds that the damage as a rule runs from 6% to 8%. Very little wheat, however, is grown in the immediate vicinity of Buffalo and it is not surprising that the few fields sown should escape serious injury.

The Hessian fly is present in overwhelming abundance. Many fields of white wheat are not worth cutting. There seems to be no difference between the early and late sown wheat. One field was sown September 15, another September 21 and another September 29 and yet 90% of each one of these fields is on the ground. Red Russian and red Mediterranean wheats seem to

be exempt thus far from attack. (J. U. Metz, East Amherst, Erie co.)

J. F. Rose of South Byron reports as follows: A large acreage of what early promised to be good wheat will not be worth cutting as a result of Hessian fly attack. A few farmers are plowing up their wheat but as the wet weather has been favorable for a good catch of clover, many will not plow it up as they are anxious to save the seeding. Very little or no white wheat will be harvested in this vicinity. Some farmers I saw yesterday had not been in their wheat fields for a few days and the grain had gone to the bad very rapidly since they saw it. I visited and examined wheat fields in three towns today and I have heard some bad reports from other neighboring towns. Several fields of red wheat have been examined and they are not badly infested as yet. 90%, however, of the wheat in this section is white, a variety known as no. 6. It has been exclusively grown for some years, as the quality is good and it is a fine yielder. The red wheat is known as no. 8. As regards proximity of other fields, there is so much grown that all fields are comparatively close. Probably there is no field that is a half mile from another and most of them are much nearer or within a quarter mile of one another. The prospect early was very good for yields of 20 to 35 bushels an acre in all fields, as there was little winter injury. A field near here belonging to G. G. Chick was not sown till the first week in October and it looked well much later in May than early sown fields, but today Mr Chick tells me that there will be no wheat. This wheat is no. 6. One farmer reports that the fly can now be found in barley. Regarding the farmers from whom I have reports, it is quite certain that some of them have estimated their yield of wheat too high. The few stalks standing are about as thick as hoop poles and when pulled up it is found that they are infested with the fly to some extent. The damage will hardly exceed 5% in the fields of red wheat. The following are reports from fields of wheat in this vicinity:

William Caswell of South Byron sowed 10 acres of white wheat September 3 and today he thought that he might get 10% of the crop. 10 acres of white wheat were sown by him on the 16th and the grain is no better than in the preceding field. 10 acres of red wheat were sown by him September 13 and this variety was not damaged to exceed 5%.

Clifford Davey of Leroy township sowed 12 acres of white wheat between September 12 and 15 and now he is plowing the ground up for beans. 12 acres of the same variety were sown by him between September 18 and 20 and this field has not been so very badly injured. Probably about one fourth of the grain is down.

Frank C. Walker of Stafford township has 40 acres of white wheat which he began sowing September 12 and finished on the 20th. Mr Walker does not expect to more than get his seed back. The grain sown first is a little worse than later plantings but there is not much difference. The first of May there was an excellent prospect of getting 25 bushels an acre. The last crop on these fields ranged from 25 to 40 bushels an acre.

Lucien Campbell of Stafford township sowed 12 acres of white wheat between September 7 and 9. Today he estimates that 15% of the grain is still standing.

James Berlin of Stafford township sowed 32 acres of white wheat September 15, the grain following barley and oats. He now estimates that he may get 5 bushels an acre. 7 acres were sown by him October 1. This was on ground used for growing corn the previous year and it is 60 rods from any other wheat. This field is no better than those sown early in the season though two weeks ago it looked as though it might produce 30 bushels an acre.

Henry Bucklin of Stafford township sowed 11 acres of red wheat between September 15 and 20 and it appears to be but little damaged up to date.

John Walsikoski of South Byron has 24 acres of white wheat sown between September 10 and 12 but he will not get his seed back.

William Scoins of Stafford township has 4 acres of white wheat sown September 7 or 8 and he will not get his seed back. 16 acres sown September 20 is no better than his earlier sown pieces, though it did not show injury as early in the spring.

Charles Buckland of South Byron has 15 acres of red wheat sown September 5 and 75% to 80% of it is apparently all right.

George Kelly of South Byron has 8 acres of red wheat sown September 1 and 80% of it is free from injury. Another field of 42 acres of red wheat sown between September 3 and 8 looks well and bids fair to yield 25 to 30 bushels an acre.

William Cork of South Byron sowed 8 acres of red wheat September 9 and 75% of it is all right. In sowing this field, the drill skipped two strips across the field and when the wheat came up the omission was seen and white wheat was sown in its place. The Hessian flies have destroyed all of this white wheat.

John Berlin of Elba township sowed 54 acres of red wheat between September 10 and 13 and he estimates that his crop will average more than 20 bushels an acre. There is very little evidence of insect injury.

The Hessian fly is also in rye, timothy and barley in this vicinity. A perfectly reliable farmer tells me that he has found as many as 50 larvae of the fly in one stalk of barley. One of our large farmers in South Byron is now cutting his barley and curing it for hay, it is so badly infested with Hessian fly. I went yesterday to see some wheat in Leroy township that is locally known as golden chaff or Clauson's golden chaff. This is a white wheat and has been but little troubled with the Hessian fly. It is no more injured than the red wheat, known as no. 8. Many farmers will sow this kind and the red wheat but if none of the flies' favorite no. 6 be sown, Mr Rose is inclined to think that these more or less resistant varieties will suffer another year.

R. L. Darrison of Lockport, Niagara co. investigated the injuries by Hessian fly in his vicinity and the reports received by him do not vary very much from those made by other parties.

The fields of white wheat, even those sown quite late in the season suffered severely while those of red wheat, whether sown early or late, escaped with comparatively little injury. White wheat as a rule suffered anywhere from 30% to 80% or more loss while rarely more than 20% of the red wheat was injured. This report covers fields representing over 200 acres. He also states that severe injuries were reported to him from Orleans and Seneca counties.

Mrs A. M. Armstrong, Belle Isle, Onondaga co. states that the Hessian fly has been quite abundant in that section. She writes: "My father, who has had an opportunity to watch a number of fields in a general way is of the opinion that late sowing is not a preventive measure and as late sown wheat does not do as well as that sown earlier, he has for years followed the practice of sowing his about September 10. He has now 25 acres sown September 25 in which the fly worked last fall, causing it to stool considerably but not many of the plants were killed while in fields of late sown grain many of the infested plants died. Specially was this true in fields where commercial fertilizers were not used in the drills. My father saw one field where the farmer was careless and let his fertilizer box become empty half way across the field. No phosphate was applied on the last trip across the field or on the headlands and in these places the fly worked very badly indeed. In some unfertilized rows there were places of a foot or more where the wheat was entirely killed. Mediterranean wheat appears to be relatively free from the pest."

Virgil Bogue of Albion, Orleans co. reports that wheat is in bad shape from the Hessian fly.

Miss Harriet M. Smith of North Hector, Schuyler co. reports comparatively little injury in her immediate vicinity, though some damage is said to have occurred at Trumansburg, Tomkins co.

J. F. Hunt, Kendaia, Seneca co. states that some pieces of wheat have been one third destroyed by Hessian fly while in others there is very little injury. He fails to find much evi-

dence in favor of the late sowing of wheat. The only pieces that were exempt were some of those sown so late that it would not be advisable to follow such an example. One field of 30 acres sown the last week in October was free from the fly. The barley crop was completely destroyed in Seneca county.

C. E. Chapman of Peruville, Tompkins co. reports that the Hessian fly is in nearly every stalk. Many fields have been nearly ruined and there will not be half a crop. The most of the sowings were made between August 25 and September 20.

C. H. Stuart, Newark, reports that in a seed bed where they have several varieties of wheat all were badly infested with the fly except one row of Dawson's golden chaff, not one straw of which is down. It is most remarkable as the rest is very bad. This check row was sowed by hand, the rest by machine, and was put in 1 inch deeper. All were sown at the same time.

W. H. Roper, Wyoming, Wyoming co. reports on a number of fields to the effect that from one fourth to one half of the wheat had become lodged by June 10 and on June 19 he reports that many fields in that vicinity will not be harvested on account of the poor crop. 4 acres of Genesee giant sown by him September 19 was not infested with the fly. It has a very coarse straw and stands up in good shape. His no. 6, sown the next day, was about half ruined as nearly as could be estimated.

The above records show very plainly indeed that the destructive work of the Hessian fly has been increasing and gradually extending during the last three years. For example, in 1899 injuries were reported only from the counties of Onondaga, Seneca and Wayne; in 1900 accounts of injuries were received in addition from Erie and Tompkins counties; and in 1901 serious complaints came from Chemung, Erie, Genesee, Niagara, Onondaga, Orleans, Schuyler, Seneca, Tompkins, Wayne and Wyoming counties. In each case the reports were accompanied by the statement that the injuries had been much greater than in preceding years. In Genesee county in particular, through the energetic action of J. F. Rose, exceptionally full data was

received and there is little reason for believing, after making allowance for the relative amounts of wheat grown in the various counties, that the conditions reported in this county were essentially different from those in some of the others. It has been estimated by good authorities that half the normal crop of New York was destroyed by the Hessian fly in 1901, entailing a loss of about $3,000,000.

An investigation in the fall of 1901 showed that in regions where the Hessian fly had been injurious, mostly red wheat (largely no. 8 in some sections, at least) had been sown and that very little or no Hessian fly could be found in such pieces. A few of the pests were found in volunteer white wheat (no. 6) but no field of this was examined as none were in the vicinity of the places visited.

Description of various stages. The adult fly is rarely observed by wheat growers. It is a small, nearly black, dark winged

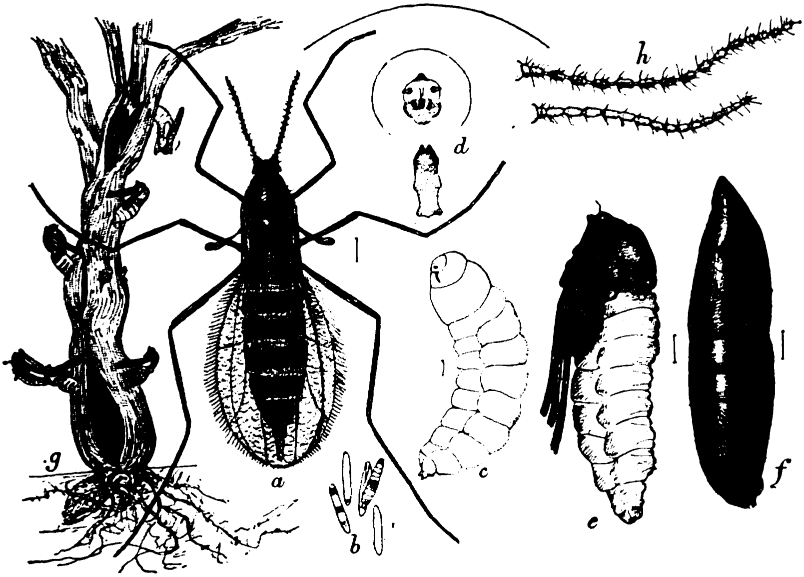

Fig. 1 Hessian fly: *a* female; *b* flaxseeds or puparia; *c* larva or maggot; *d* head and breast bone of same; *e* pupa removed from puparium; *f* puparium or flaxseed; *g* infested wheat stem; *h* male and female antennae; *b* and *g* about twice natural size, all others much more enlarged (after Marlett, U. S. dep't agric. Farm bul. 132)

midge about $\frac{3}{32}$ inch in length and possesses very long, slender legs. There are a number of closely related flies which have a similar appearance but ordinarily if one about this size and having the general appearance represented in fig. 1*a* is found on

young plants in wheat fields, it is very likely to be this notorious pest.

The puparium or "flaxseed" stage is so well known that a description is hardly necessary. The "flaxseeds" are about $\frac{1}{8}$ inch long, of light brown color and occur near the base of the plants. One very much enlarged is represented at *f* in fig. 1.

The slender, delicate, greenish white maggots are also somewhat familiar to the wheat grower and a detailed description of them in this connection is hardly necessary. The full grown larva is about $\frac{1}{8}$ inch long and it is usually found in the field between the sheath and the stem of the young plants.

The eggs have been sufficiently characterized in a following paragraph treating of their deposition.

Food plants. The food plants of the Hessian fly are of considerable importance because if it is able to subsist on a number of grasses and grains its control is manifestly much more difficult. The Hessian fly was early recognized as a pest of wheat, rye and barley, and despite the fact that records are occasionally met with of its occurrence in timothy and other grasses and grains, the weight of evidence seems to indicate that it does not live to any extent at least on anything but the above crops. It is possible that at exceedingly rare intervals, comparatively speaking, a few may mature on timothy, but in some instances at least related species have been confounded with it.

Life history. Normally there are two generations in this latitude though there may be several supplementary ones. The adult fly may deposit from 100 to 150 eggs, according to Marchal, placing them between the ridges on the upper surface of the blades of young wheat. Individuals of the spring brood occasionally thrust their eggs beneath the sheaths of the lower leaves. The process of oviposition has been carefully described by Mr Herrick as follows:

While depositing her eggs the insect stands with her head toward the point or extremity of the leaf, and at various distances between the point where the leaf joins and surrounds the stalk. The number found on a single leaf varies from a single egg up to 30 or even more. The egg is about $\frac{1}{50}$ inch long, cylindric, rounded at the ends, glossy and translucent, of a pale red color,

becoming in a few hours irregularly spotted with deeper red. Between its exclusion and its hatching these red spots are continually changing in number, size and position and sometimes nearly all disappear. A little while before hatching two lateral rows of opaque white spots, about 10 in number, can be seen in each egg.

The flies may occur any time after the wheat is up and before killing frosts, and possibly, as pointed out by Dr S. A. Forbes, *between* killing frosts. The eggs hatch in about four days and the maggots or larvae then make their way down the leaf to the base of the sheath. These soft maggots do not burrow, but lie between the sheath and the stem and absorb their nourishment from the adjacent soft tissues, which gradually become depressed and give way as the little insect develops. The maggots are usually found in the fall close to the roots of winter wheat and at or beneath the surface of the soil, while the spring larvae are more common about the second or third joint of the plants. The larval transformations occupy about 20 days but their duration is considerably affected by weather conditions. The duration of the pupal stage is very variable and is much affected by climatic conditions. Cold or heat and dryness tend to lengthen and heat and moisture to shorten the duration of the different stages, specially the pupal. The winter is passed by this insect in the "flaxseed" or pupal stage. The spring brood of flies emerge in April or May and in turn lay eggs on the more luxuriant leaves and another life cycle may be completed in about 30 days.

Number of generations. The short time necessary to complete the life cycle permits a number of broods in one season and apparently there are as many generations as weather and food conditions will permit, and we may expect constant breeding of this insect during the growing season if continued damp weather enables wheat, barley and rye to grow luxuriantly throughout that period. During midsummer as a rule the fly, if it appears at all, will find only a little volunteer wheat in fit condition for it to live on, but this was very different with barley in 1901. The spring brood had passed through its transformations and the continued moist weather brought out the flies in hosts. Eggs were laid in large numbers in the barley, specially in that which

was sown late, and in early July many fields in Genesee county were badly infested. The pests were near the ground in the latest sown barley and in that early sown, they occurred from 10 to 12 inches from the ground, showing at least, that the insect breeds by preference in the soft growth and inferentially that it thrives only indifferently in the older, harder growth. This relation between the rank succulent growth of the grain and injury by the Hessian fly was further shown on one hilly patch of wheat. There was considerable grain on the gravelly, comparatively dry knolls while in the more moist, probably poorly drained gullies the stalks of wheat were very scattered. Here seems to be a possible reason why a variety of wheat may be comparatively "fly proof" in one section and not in another, since its apparent resistance may depend very largely on the relative hardness or maturity of the stalk at the time the flies appear and deposit eggs and this might easily vary in widely separated sections during the same season. Another generation might easily have developed, so far as time is concerned, between the middle or the latter part of July, at which date the above mentioned brood attained its maturity, and the period when the normal fall brood appears, which is usually before September 20 in New York. The above shows that four generations and possibly more may develop in a season, but it should be distinctly understood that, as a rule, only two full broods are developed, and that the intermediate summer generations are usually very limited and that their development is very dependent on weather and crop conditions.

Emergence and flight. This is an exceedingly important matter, because on its correct understanding rests one of the most successful methods of preventing injury by this pest. This, like the development of the summer generations, is dependent on weather conditions. The following rules will aid in understanding the situation:

1 The flies may remain an indefinite period in the "flaxseed" or pupal stage during dry weather.

2 "Flaxseeds" or pupae are very likely to develop flies in large numbers during a period of damp, warm weather.

3 Adults are killed by heavy frosts but this is not true of larvae and "flaxseeds" or pupae and hence flies may appear and deposit eggs *between* killing frosts.

4 Under certain conditions some of these insects may spend nearly a year in the "flaxseed" stage.

The above rules show that egg-depositing flies may appear at any time during the growing season, providing weather conditions are favorable, though naturally we would expect them to appear in great numbers only at the first favorable period after a large brood had attained the "flaxseed" or pupal stage. Thus, as our springs are usually warm and moist, this means that ordinarily most of the "flaxseeds" will develop flies in the latter part of April or early May. Then there must be a sufficient period for the completion of a life cycle before another brood of flies can appear and if at that time and for a considerable period thereafter the weather be dry and hot, comparatively few or no flies will appear till conditions change and consequently we can not tell just when flies will appear again.

We do know, however, that early sown winter wheat is very apt to become badly infested in the fall while late sown wheat frequently escapes. In the first instance the young wheat is up and receives a deposition of eggs before or *between* killing frosts, while in the other case it escapes. Weather conditions must always be considered in sowing winter wheat. The general rule for the safe sowing of winter wheat may be stated as follows:

Moist warm weather in early fall will permit the safe sowing of wheat at a relatively early date, but when the early fall is dry, delay sowing till the latest possible date. The normal or average date when wheat can be sown in New York without danger of its becoming infested with the Hessian fly is about September 20.

Effects of continued dryness and moisture. Following is an interesting record by Dr Riley:

It has long been known that the Hessian fly flourishes best when the chinch bug flourishes least; in other words, that wet weather favors it. The prejudicial effect of drouth has not been hitherto observed, that we are aware of, but it was very noticeable in parts of Ohio, where the puparia literally dried up. Our attention was first called to the general death of the

insect in the "flaxseed" state by E. W. Claypole of Yellow Springs O. and our observations subsequently confirmed his experience. The intense heat had not only dessicated the Cecidomyia but what is still more remarkable, in most cases the parasites also.

On the other hand wet weather favors their development and under the influence of frequent showers the flies have been known to issue in large numbers from their "flaxseed" cases in early summer. This was very nicely illustrated last July in case of the barley attack. The continued rains in the spring induced the flies to complete their transformations early and July 10 a number of places were seen where the spring brood of the fly had completed its transformations and departed. This was further confirmed by finding several large fields of barley sown about May 15, badly infested with larvae and young puparia of this insect. The barley attack was confined largely to the upper, softer nodes and in at least one large field the infestation was very thorough. Every stalk was infested with a few of the pests and eight plants taken at random from this field contained from 19 to 54 individuals, most of them being in the larval stage. This serious infestation is very interesting when compared with the following record of the weather in two localities in that section of the state. The table given below is compiled from the records of the New York state weather bureau and shows the total precipitation in each of the growing months and the number of rainy days.

TABLE OF PRECIPITATION

	Year	Month	Total precip. in in.	No. rainy days
Alden, Erie co.				
	1900	Aug.	2.48	7
		Sep.	3.26	7
		Oct.	3.18	7
		Nov.	8.42	16
	1901	Mar.	3.09	12
		Ap.	4.34	11
		May	4.49	18
		June	1.49	7
Elba, Genesee co.				
	1900	Aug.	2.39	11
		Sep.	2.69	7
		Oct.	3.59	8
		Nov.	3.99	21
	1901	Mar.		
		Ap.	4.25	10
		May	5.13	19
		June	3.38	10

It will be seen from the above table that last May was very wet, rain falling 18 and 19 days respectively in the two localities. It is no wonder that the spring generation of the fly completed its transformations and that the adults were ready to oviposit and infest the late sown barley.

Signs of infestation. The first indication of attack is found in the darker color of the leaves and a tendency among the young plants to stool freely. The broader lower leaves and the absence of a central shoot, it having been killed, are also noticeable in infested fields. As the attack advances the infested plants turn yellow or brown and die and the maggots may be found at the base of the leaves near the ground. The spring brood attacks tillers or laterals which were unharmed in the autumn, dwarfing and weakening the stems so that the grain usually lodges before ripening and can not be harvested well.

Rule for determining time for sowing winter wheat. This has been the subject of considerable study by Prof. Webster of Ohio and Dr Hopkins of West Virginia. The latter, in Bulletin 67 of the West Virginia agricultural experiment station, has given in considerable detail much data bearing on this subject and in that bulletin he elaborates a very interesting rule for determining this date in various sections of the country. His results are not only based on considerable scientific research, but they have been confirmed by practical experience. Dr Hopkins finds: 1) That under similar conditions of land surface, other than altitude, there is a normal rate of difference of time in the periodical phenomena of plants and animals for all differences in latitude and altitude. 2) That under normal conditions the rate of average variation for the beginning or ending of any phenomenon is not far from one day for every fourth of a degree of latitude, or for every 100 ft of elevation. Using this rule and taking as a base the time, September 25, determined by Prof. Webster through observation as the date when the Hessian fly normally disappears from fields about Columbus O. in latitude 40° and with an altitude of 800 ft, it will be found that in Genesee county, latitude 43°, the normal period when wheat can be sown without injury by the Hessian fly is September 21. This calculation is for sea level and the date may be pushed forward

approximately one day for each 100 feet of elevation. The method of reaching this conclusion is as follows: the 3° difference in latitude between the two places gives an allowance of 12 days, that is four for each degree of latitude, and as Genesee county is farther north, the 12 days may be subtracted from the date given for Columbus, but before subtracting this, the date for Columbus must be brought down to a sea level calculation, and as that date is September 25 at 800 feet above sea level, the safe date must be eight days later, or approximately one day later for each 100 feet less in elevation. This brings the safe date at Columbus O., were it at sea level, at October 3, and bringing this date forward 12 days, the allowance made for the 3° difference in latitude, we have the normal date for Genesee county in localities at sea level. This date, September 21, may then be advanced one day for each 100 ft elevation above sea level.

At first sight this rule may appear a little cumbersome, but it is really a very simple one and it certainly deserves a trial by every farmer troubled with the Hessian fly. If it accomplishes nothing more, it gives a basis on which to begin experiments, and we are therefore able to approximately figure the safe date for any locality and then this should be checked up by past experiences or put to the test of future use. The farther north the location and the higher the elevation, the earlier may the wheat be sown with safety.

Parasites. The parasites of the Hessian fly are very important, since were it not for them it is extremely probable that it would be much more destructive than it is. The easiest way to determine the proportionate number of parasites in any one field is to take infested stalks and breed the adult insects from them. A net-covered jelly tumbler or fruit jar, taking care to avoid close covers and resulting molds, will answer very well as a breeding cage. Later in the season, after the parasites have emerged under natural conditions, an examination of "flaxseeds" in the field will give some idea of the relative number which have been killed by these tiny friends of man, since each having a cir-

cular hole in the side has produced a parasite and not a fly. Sometimes fully nine tenths of the Hessian flies are destroyed by parasites and occasionally entomologists have experienced difficulty in breeding any adult flies from infested wheat stems because the parasites were so numerous.

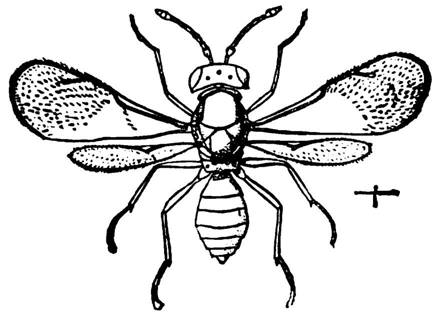

Fig. 2 Merisus destructor (after Riley)

The above notes give some idea of the importance of these little creatures. One of the most efficient of these parasites is known as Merisus destructor Say, a minute four winged fly which is represented in the accompanying illustration. It occurs not only

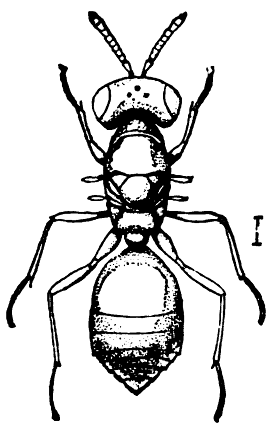

Fig. 3 Boeotomus subapterus (after Riley)

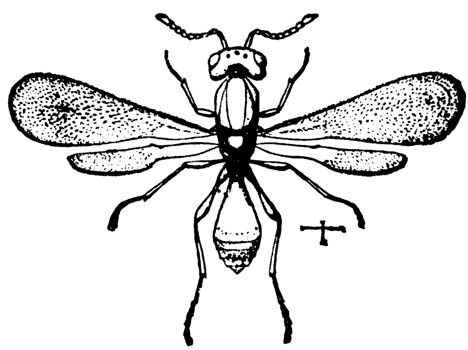

Fig. 4 Platygaster herrickii Pack. (after Riley)

throughout the American territory affected by the Hessian fly but it is known in England and Europe.

Another parasite which ranks next in economic importance to the preceding is known as Boeotomus subapterus. It is frequently wingless as seen in fig. 3. The proportion of winged to wingless individuals is said to vary at different seasons of the year. In Missouri this species has been bred from infested wheat stalks more commonly than the preceding.

Platygaster herrickii Pack., represented in the accompanying figure, is another common parasite of this grain pest.

This little parasite has been credited with puncturing the Hessian fly eggs and laying its own therein to hatch later and consume the larva. This was considered a very improbable method of attack, as most true egg parasites complete their life cycle within the egg itself though the observations of Marchal on Trichasis have shown the probability of such a mode in this species.

Entedon epigonus Walker. This species was introduced into this country in 1891 through the efforts of Dr C. V. Riley who received parasitized pupae from Fred Enoch of England. These were distributed to Prof. Forbes of Illinois, Prof. Cook, then of Michigan, and Prof. Webster, then of Indiana. It is impossible to state even at this date how much benefit may ultimately result from the introduction of this parasite, but Mr Marlatt, writing of the Hessian fly in 1901, states that considerable good may be expected from it. It had become established in the vicinity of Washington D. C. and presumably in Illinois, but whether it will continue to hold its own and prove an efficient aid in the control of this serious pest remains to be seen.

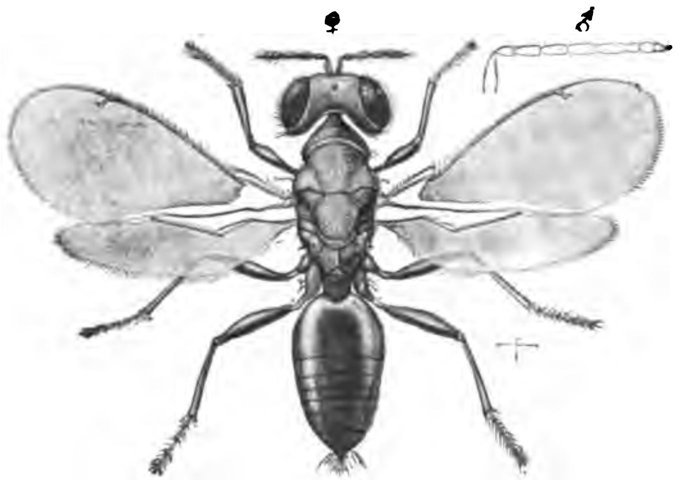

Fig. 5 Entedon epigonus Walk. (after Howard, Insect life, 7:356, 1895)

Two other primary parasites of the Hessian fly are known in America. They are Pteromalus pallipes Forbes and Eupelmus allynii French.

Preventive and remedial measures. *Late sowing.* One of the most important preventive measures is to delay sowing till after the adult flies have deposited their quota of eggs and perished. In New York this means delaying sowing as a rule till September 20 or a little later. A preceding paragraph gives more specific directions for the determination of the date when wheat may be safely sown in different latitudes and at varying altitudes. The difference in latitude in New York is relatively slight but altitude has considerable influence on the period when wheat may be sown with safety. The experiences of 1900 and 1901 have demonstrated anew the destructive powers of this pest and as many of the holdings in western New York are exceedingly small and the fields of wheat so near one another that it is very easy for the flies to make their way from one to the other, the delaying in the date of sowing is of itself not sufficient to guaranty immunity from the ravages of this insect.

Resistant varieties. There is probably no such thing as absolutely fly proof wheat but experience has shown that the varieties known as no. 8, Dawson's golden chaff, White chaff, Mediterranean, red Russian, prosperity and democrat have withstood the attack of the Hessian fly very successfully in western New York, even when the beardless, weak-stemmed white wheat known as no. 6 was very seriously injured and sometimes totally destroyed. Some of the varieties badly affected by the fly are better yielders than the above but the only safe way is to sow one which is able to resist attack to a considerable extent. It is very remarkable that while Dawson's golden chaff was so free from injury in the Empire state, it sustained much harm last spring in Canada, its native home.

Good culture. Thorough culture counts for very much when trying to grow a good crop of wheat. The field should be thoroughly prepared and the land gotten into excellent condition before it is considered fit for the crop. An endeavor should be made to get a growth of firm straw and to produce plants vigorous enough so that if attacked they will tiller

abundantly and thus avoid a serious decrease in yield. A badly drained soil, where conditions favor a moist growth of succulent straw, appears to be quite favorable to the fly and in some such places the injury was much more manifest than on higher well drained land. Prof. Webster of Ohio, who has studied this insect for over 15 years, believes that four fifths of Hessian fly injury can be prevented by a better system of agriculture.

Trap strips. This device has long been recommended by entomologists and was earnestly advocated by Dr Fitch but there has been considerable difficulty in getting farmers to take up the idea and go to the trouble of preparing a little ground, sowing it early and then turning it under soon after the flies have deposited their eggs. Many wheat growers prefer to wait and take their chances on the crop not being seriously injured by the fly. S. W. Wadhams of Garland N. Y. made a test of this plan with most excellent results. Aug. 25, 1900 he sowed two widths of the drill round a 20 acre field and then sowed the remainder on September 27 and 28 and just before the last sowing came through the ground, his decoy strip was plowed under, put in condition and resown. At the time of plowing he found that practically every leaf and stalk of the wheat was completely covered with the eggs of the fly, so that the strip turned brown and myriads of the flies swarmed up in front and over the horses as they walked over it. The result was that in 1901 he harvested 21½ bushels of no. 6 wheat an acre. This yield was secured when other fields of no. 6 wheat were so badly injured as to produce from three fourths of a crop to almost nothing. Mr Wadhams sowed another trap strip Aug. 20, 1901 and on September 14 he found that the young wheat plants were being rapidly covered with eggs of the Hessian fly, and he now suggests that the trap or decoy strips be plowed under about nightfall or in the cool of early evening, at a time when the few remaining flies, if any be alive, would naturally be resting on the wheat plants, and the chance of covering them deeply would therefore be immensely increased. Agricultural practice in western New York does not always admit of the

trap strip round the sides of a field to be sown with wheat and fortunately this is not necessary because, from what we know of the habits of the flies, it is very likely that they would be attracted to a patch of wheat sown some little distance, a half mile or more from the field which it was proposed to put into wheat. It would be better undoubtedly to have a trap strip beside the field, but if that is impossible, much may be gained by sowing a small patch of wheat at some little distance and turning it under as proposed above.

Burning stubble and chaff. This has been recommended by a number of writers but in western New York at least the common practice of sowing to grass with wheat, prohibits the burning of the stubble. This objection would not hold in regard to burning the chaff from the threshing machines and this might well be done in case the wheat is at all infested by the Hessian fly.

Plowing under stubble. This is also impractical in cases where grass follows wheat but in other instances it would certainly do no harm if the stubble is at all infested, and it is advised where no additional labor or expense be entailed.

Rotation of crops. The judicious rotation of crops will undoubtedly do considerable toward reducing the ravages of this insect, particularly if care is taken to have the wheat fields of successive years at some distance from each other.

Destruction of volunteer wheat. The Hessian fly breeds in volunteer wheat, and wherever possible without incurring undue labor and expense such wheat should be destroyed or plowed under before it can produce the adult flies.

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1896 **Smith, J. B.** N. J. agric. exp. sta. Rep't, p. 434-35 (injuries in New Jersey).

1897 **Fletcher, James.** Experimental farms (Canada). Rep't, p. 226-27 (notes on injuries).

1897 **Marchal, Paul.** Les Cecidomyies des céréales et leurs parasites. Société entomologique de France. Annales. 66:1-42, 43-47, 51-62, 80-100 (detailed account with original observations on life history, transformations and parasites).

1897 **Webster, F. M.** O. state bd agric. 51st rep't, p. 493-95 (remedial measures for Hessian fly).

1898 **Felt, E. P.** Hessian fly in Pennsylvania. Country gentleman, July 14, 63:546-47 (general account); Hessian fly, Nov. 17, p. 906 (preventive measures recommended).

1898 **Fernald, H. T.** Hessian fly in wheat. Pa. dep't agric. Folder, p. 1-4 (brief general notice).

1898 **Howard, L. O.** Science. new series, 7:246-48 (review of Marchal's paper).

1898 **Johnson, W. G.** U. S. dep't agric. div. ent. Bul. 17, new series, p. 94 (injuries in Maryland).

1898 **Osborn, Herbert.** Hessian fly in the United States. U. S. dep't agric. div. ent. Bul. 16, new series, p. 1-57 (detailed account).

1899 **Felt, E. P.** Hessian fly. Country gentleman, Aug. 10, 64:628-29 (general account); Hessian fly, Nov. 22, p. 942 (rule for ascertaining date for sowing).

1899 **Fernald, H. T.** Pa. dep't agric. Bul. 46, p. 5-8 (brief general notice).

1899 **Fletcher, James.** Experimental farms (Canada). Rep't, p. 173-75 (injuries and remedies).

1899 **Lugger, Otto.** Minn. agric. exp. sta. Bul. 64, p. 551-57 (brief general account).

1899 **Pettit, R. H.** Insects of the year. Mich. agric. exp. sta. Bul. 175, p. 358-61 (brief general account).

1899 **Webster, F. M.** O. agric. exp. sta. Bul. 107, p. 257-88 (detailed account).

1900 **Hopkins, A. D.** W. Va. agric. exp. sta. Bul. 67, p. 239-50 (general account with rule for determining time of sowing).

1900 **Webster, F. M.** O. agric. exp. sta. Bul. 119, p. 239-47 (observations in 1899 and 1900).

1901 **Felt, E. P.** Hessian fly. Country gentleman, May 30, 66:442 (remedial measures); Hessian fly, June 13, p. 486 (request for data); *same* N. Y. farmer, June 13, p. 8; —— June 27, p. 7; Am. agric. June 22, p. 816, col. 1; Hessian fly in New York. Country gentleman, Oct. 3, 66:799-800 (summary account of injuries in 1901 and remedial measures).

1901 **Forbes, E. B.** Minn. agric. exp. sta. Press bul. 13, p. 1-11 (brief general account).

1901 **Garman, Harrison.** The Hessian fly. Ky. agric. exp. sta. Bul. 96, p. 193-98 (period of flight and oviposition).

1901 **Marlatt, C. L.** U. S. dep't agric. Farmers bul. 132, p. 13-22 (brief general account).

1901 **Powers, S.** Hessian fly. Country gentleman, Oct. 31, 66:889 (historical notice and remedial measures).

1901 **Roberts, I. P., Slingerland, M. V. & Stone, J. L.** Hessian fly. Cornell univ. agric. exp. sta. Bul. 194, p. 239-60 (summary account for 1901).

1901 **Slingerland, M. V.** Hessian flies and rag weed. Rural New Yorker, 60:612 (Hessian fly does not breed in rag weed; use of decoy strips); Facts about fly proof wheat, 60:627 (notes on the resistance of various varieties).

1901 **Wadhams, S. W.** Hessian fly. Country gentleman, Sep. 12, 66:740 (results obtained with trap crop); Traps for Hessian fly. Rural New Yorker, Oct. 5, 60:674-75 (method of using trap crop).

1901 **Webster, F. M.** Hessian fly in the middle west. Rural New Yorker, 60:219 (parasites bred abundantly).

1901 **Webster, F. M.** Wheat and Hessian fly. Rural New Yorker, 60:537, 553 (notes on conditions from various localities).

1902 **Felt, E. P.** U. S. dep't agric. div. ent. Bul. 31, new series, p. 22-24 (injuries in 1901).

1902 **Stedman, J. M.** More important insects injurious to wheat in Missouri. Mo. state bd agric. Rep't 1902. Separate p. 23-34 (general account).

NOTES FOR THE YEAR

The following records include some of the more important observations made during 1901. Special attention has been given to forest and shade tree insects throughout the summer. Systematic collecting was pursued at Karner, 7 miles west of Albany, where there is an admirable growth of scrub oaks and small hard pines. These conditions were excellent for securing all the insects affecting these trees, and the results of the season's work, together with that of previous years, will be incorporated in a special bulletin on forest insects now in preparation. The notes relating to the various species mentioned below have been grouped under convenient heads, so that they may be of greater service to the parties interested in the practical aspect of the work.

Fig. 6 Work of woodpeckers on plumtree infested by fruit tree bark beetle (original)

Fruit tree pests

Fruit tree bark beetle, Scolytus rugulosus Ratz. This insect appears to be on the increase in various parts of the state, as several complaints and personal experience seem to indicate. Our report for 1900, p. 989 (N. Y. state mus. bul. 36) records an attack by large numbers of the beetles on a peachtree Sep. 7. May 22, 1901, in the same locality our attention was attracted to some young plumtrees, from which a large proportion of the bark had been stripped, and investigation showed that the bark and sapwood of these trees were almost alive with pupae of this insect. The woodpeckers had found them out, and had literally stripped the bark from the infested trees and splintered the surface of the wood in their efforts to get at the pupae. A hairy woodpecker, Dryobates villosus Linn., was

observed in the vicinity of the trees, and it was probably this species which preyed on the bark beetles. This is a striking illustration of the value of woodpeckers and their perseverance in digging out such small insects. These pupae were undoubtedly the progeny of the fall brood of beetles, which were observed Sep. 7, 1900, entering trees in large numbers. Aug. 1, 1901, adults of Scolytus in some numbers were entering the bark of a young dying appletree, a victim of Saperda candida, at Pittstown N. Y. The bark beetles gnawed many minute holes about $\frac{1}{16}$ of an inch deep and of the same diameter. Some of these holes were deserted, and in other places the beetles were at work making the primary entrance or beginning a gallery. This observation in connection with the preceding ones shows very clearly that the fall brood of beetles, if there be a distinct one, as is very probable, extends in the eastern part of New York state from Aug. 1 till Sep. 7 or later. This is still further confirmed by our finding at Ripley N. Y. Sep. 5, 1901, beetles entering plumtrees in large numbers.

FIG. 7 Work of fruit tree bark beetle in plum (original)

The presence of pupae and recently transformed beetles in the plumtrees examined May 22 would indicate that the adults would probably have emerged within a short time. There are therefore at least two generations annually in New York state, and the short period necessary for the completion of the life cycle permits more. It may be that more do occur, but there does not appear to be any good evidence to that effect, at present. Another cheering feature in the last mentioned attack was the breeding of numbers of the beneficial parasite known as Chiropachys colon Linn.

Grapevine fidia, Fidia viticida Walsh. This pest has become thoroughly established in some of the vineyards about Ripley N. Y., where it has already destroyed several and is seriously injuring others. An examination of the infested locality early in September 1901 showed that the badly infested area was still quite limited, though the beetles were known to occur in small numbers over a considerable tract. Mr F. A. Morehouse stated that he found the pest most injurious to those vines from which the earth had been plowed away more or less,

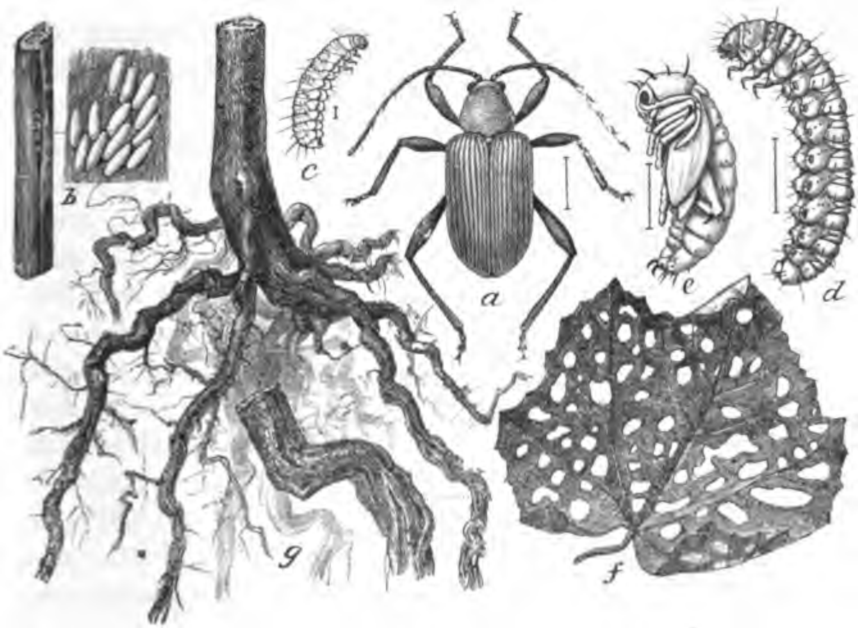

Fig. 8 **Fidia viticida**: *a* beetle; *b* eggs represented natural size under fold of bark and much enlarged at side; *c* young larva; *d* full grown larva; *e* pupa; *f* injury to leaf by beetles; *g* injury to roots by larvae—*b* (in part) and *f* and *g* natural size, rest much enlarged. (After Marlatt, U. S. dep't agric. Yearbook 1895. p. 394)

thus affording the larvae a better opportunity to get at the roots, while those well protected by earth suffered comparatively little. This is certainly worthy of further trial; and, while it can hardly be expected to afford absolute immunity, it may decrease the injury materially. Spraying the vines toward the last of June or early in July with arsenate of lead, preferably using the prepared paste form now on the markets, will do considerable to lessen the damage by poisoning the

beetles before they have had an opportunity to deposit many eggs.

It is worthy of note that this species had been in the eastern part of New York state for a number of years without attracting attention by its ravages. Specimens of this beetle were taken by the late Dr Lintner June 30, 1880, at Schenectady N. Y. and on Virginia creeper at Albany July 20, 1882. The 25th of last July this pest was rather abundant on Virginia creeper at Albany, yet no serious injury to grapevines in this vicinity has been observed.

FIG. 9 Colaspis brunnea, much enlarged (original)

Brown colaspis, Colaspis brunnea Fabr. This pest, in company with Fidia viticida Walsh and Systena hudsonias Forst., was received from Fredonia N. Y. with the complaint that grapevines had been seriously injured. Much of the harm was undoubtedly caused by the Fidia; but, as this species of Colaspis was present in considerable numbers, and as it is well known as an enemy not only of the grapevine but also of strawberry plants, it probably caused considerable injury. This species was also taken in very small numbers on hard pine, Pinus rigida, and on willow at Karner N. Y. July 8. The beetles are very general feeders, having been previously recorded as feeding on such unlike plants as beans, clover, buckwheat, strawberry, potato and corn.

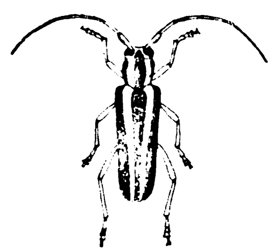

FIG. 10 Appletree borer, adult beetle

Round-headed appletree borer, Saperda candida Fabr. A number of severe injuries by this well known pest have been brought to notice during the year. It was quite common and destructive at Pittstown and vicinity, as reported by W. C. Hitchcock, and the reason for this is found in the fact that little or no attention

is paid to its operations. It was not only seriously damaging young trees there, but it was commonly present in greater or less numbers at the base of the older ones. It was found quite abundant in an orchard of young trees in East Greenbush, where seven good sized grubs were taken from the base of a small tree not over 3 inches in diameter. There is no doubt that persistent and thorough digging or cutting out of these grubs and the use of a protective wrapper at the base of the trees are all that is necessary to control this pest. The cost of these measures is very slight compared with the value of the orchard.

Red-headed flea beetle, Systena frontalis Forst. The destructive tendencies of this little black, red-headed flea beetle have been noticed in a recent report. This year it was received, in company with other insects, as a depredator on grapevines. It probably, as in preceding cases, had bred in weeds, and, when numerous, turned its attention to more valuable plants.

Fig. 11 Red headed flea beetle much enlarged (original)

Forest tent-caterpillar, Clisiocampa disstria Hübn. This insect has been a most serious pest in New York state for the last four or five years, and in localities here and there it has proved exceedingly destructive this season. The outbreak of 1901, so far as could be learned, was much more limited in area than in earlier years and confined largely to sections adjacent to where the insect had been specially abundant previously. The caterpillar appears as a rule to be unable to exist in large numbers in one locality for more than four or five years in succession. This is probably to be explained by the local activity of natural enemies. Another marked feature has been the increasing predominance of the pest in orchards. It is perhaps hardly necessary to add that most of the injuries in orchards could have been prevented by timely and thorough spraying.

Cenopis diluticostana Wlsm. The peach twig moth, Anarsia lineatella, is a well known boring pest of peach twigs, but the results of this summer apparently show that some other species may be involved and produce very similar injury. The 22d of last June Mr C. H. Stuart of Newark N. Y. sent in peach twigs affected with what he thought was the common peach twig borer. On breeding it, however, it proved to be the above named insect, which was kindly determined by Prof. C. H. Fernald. The notes made at the time on the material sent are of interest and are here transcribed. All the buds had been killed on three or four twigs, 4 to 6 inches long, and those bearing green leaves also had masses of gum of considerable size. The young fruit had also been attacked somewhat. The bark and the sapwood under the masses of fresh gum had been seriously mined. In some places the mines were linear and in others were expanded and very broad. Mr Stuart subsequently wrote that there was hardly a branch of the tree that was not affected, and that many apricot, plum, cherry, apple, peach, willow and other trees for miles on each side were injured, though such an attack had not been previously noted. The trees recovered later, but many small branches were killed.

This insect was described by Lord Walsingham in 1879 in his *Illustrations of typical specimens of Lepidoptera Heterocera in the collection of the British museum*, pt 4, "North American Tortricidae," p. 18. The specimen from which his description was drawn up came from the eastern states of North America. Prof. Fernald in 1882 redescribed this species as Cenopis quercana in the transactions of the American entomological society, 10:69. His description of the moth is herewith transcribed.

Head, palpi and antennae, reddish gray in the males, concolorous with the thorax and fore wings in the females. Thorax and fore wings dull rust red. Basal patch, median and subapical bands lighter in the males and inclining to yellowish on the costa with strong greenish reflections when seen in an oblique light, showing most strongly in the females. Fringes lighter. Hind wings and abdomen above, light fuscous, lighter beneath. Underside of forewings dull reddish, fuscous on the cell, the lighter markings of the upper side scarcely showing. Expanse, male 14 mm; female, 16 mm.

The specimens from which the above description was drawn were bred from leaves of oak by Prof. Comstock, probably at Ithaca N. Y. and from cultivated cherry by Miss Murtfeldt in Missouri. Prof. Fernald states that there are no other records concerning this insect; and, while most of the above recorded injury to peach twigs may possibly be the work of the peach twig borer, it is certainly of interest to know that this species also attacks the peachtree, and further investigation may show that it is responsible for considerable of the injury. The one bred specimen pupated in a leaf. The empty pupal case was about $\frac{3}{8}$ inch in length, light brown in color, and the dorsum of each of the abdominal segments bore two trans-

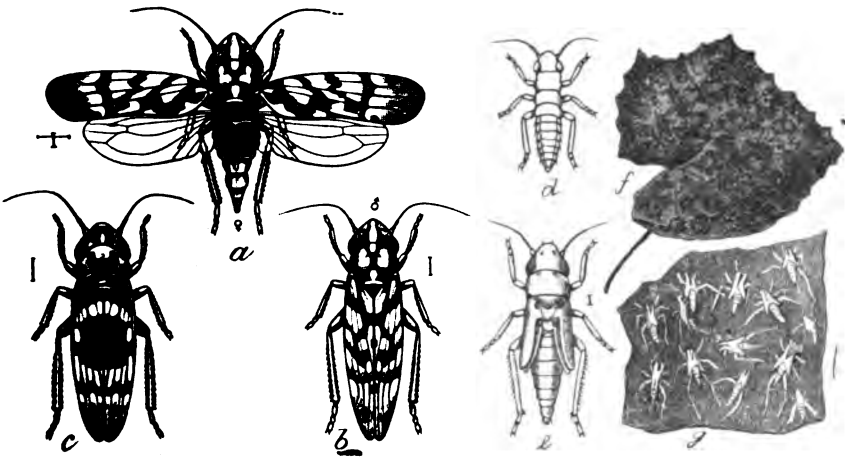

FIG. 12 Typhlocyba (sp.): *a* T. comes Say, female; *b* T. comes Say, male; *c* typical form of T. vitifex; *d* larva; *e* pupa; *f* appearance of injured leaf; *g* cast pupal skins. (After Marlatt, U. S. dep't agric. Yearbook 1895. p. 401)

verse rows of serrations, the anterior rows being very well developed and consisting of from seven to 10 dark, chitinous teeth. The cremaster is dark brown, blunt at the extremity and tipped with six or eight rather stout, though small, recurved spines.

Grapevine leaf hopper, Typhlocyba comes var. vitis. This little leaf hopper is very familiar to many grape growers, and during the past season it has been exceptionally abundant in parts of the grape-growing districts of Chautauqua county. The foliage in many vineyards was very seriously affected, parti-

ularly the shaded, underleaves. The work of this species was less noticeable in vineyards where clean culture was the rule, although the pest was very generally present.

Shade and forest tree pests

Elm leaf beetle, Galerucella luteola Müll. This imported species continues to be a serious enemy of European elms in Albany, Troy and vicinity. The depredations of this pest have been so severe as to lead to the maintenance and operation of two power spraying outfits by the municipality of Albany. Two are also in operation by a private owner in Troy, where they are kept busy throughout the spraying season, each individual paying for the treatment of his own trees. The general condition of the shade trees in both cities is much improved by this work, and, considering all the trees in the streets of both cities, the results are decidedly in favor of Albany. This is probably due almost entirely to the fact that it is much more economical to take a street at a time and spray all the trees than to go hither and thither as desired by private persons. The former is possible only where the city undertakes to spray all the trees on the streets, while the latter must obtain where spraying depends on the will and financial ability of the owner of the abutting property. It might be well to add that as a rule Albanians neglect the trees on their own premises, while people of Troy who have spraying done, invariably include the trees on the premises as well as those in front of the property. The elm leaf beetle has almost undisputed sway in the poorer parts of Troy, because the residents can not afford to have their trees sprayed; while in Albany, these, as well as those inhabited by the wealthier class, are treated, with most beneficient results, because it is in these poorer quarters that shade is most urgently needed. It therefore seems to me advisable to urge the prosecution of such work, when necessary, on municipalities,

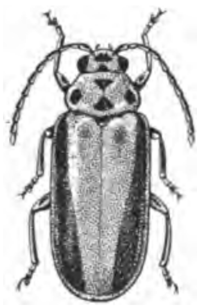

Fig. 13 Elm leaf beetle, adult, much enlarged (reduced from Howard, U. S. dep't agric. Yearbook 1895)

rather than to allow it to depend on the enterprise of private individuals, solely because it means the greatest good to the greatest number at a minimum expenditure. This imported pest is slowly extending its range northward of Albany and Troy, and, in some localities where no spraying is done, it is this season proving a scourge to both European and American elms.

The cost of spraying shade trees in cities and villages is a very important matter; and in a former bulletin[1] some attempt was made to ascertain the expense connected with such operations. Figures at that time gave the cost as ranging from about 15c to 56c a tree. Some recent estimates have come into my possession regarding the cost of spraying in Albany and its immediate vicinity. Mr H. W. Gordinier states that in Lansingburg N. Y., where he had a contract to spray all the trees in the village and where most of the elms are very large, the cost per tree for one spraying averaged about 23c, while in Troy, where he sprays the trees of private individuals here and there over the city and is necessarily obliged to travel considerably to go from one lot of trees to another, the cost of spraying ranges from 50c to 60c a tree for each spraying. In both cases the rather more expensive arsenate of lead was used. Both of these figures apply to elmtrees infested with the elm leaf beetle; and, as all who have had experience with this pest know, it requires very careful and thorough spraying in order to obtain satisfactory results. The average cost per tree for spraying in Albany in 1901, using 5 pounds of Bowker's disparene to each 100 gallons of water, was 22c, and the average number of trees sprayed per day by each power spraying outfit was 40. Two were operated under one foreman. However, it was found that, where the trees were small and of a nearly uniform size, such as Norway maples about 30 feet in hight, 180 trees could be sprayed in one day.

The village of Saratoga Springs undertook to spray its many large maple trees, ranging in hight from 20 to 80 feet, in 1900,

[1] N. Y. state mus. Bul. 20. 1898. p. 21-22.

and for that purpose it purchased two power spraying outfits, each provided with an elevating apparatus such as is commonly seen on repair wagons of electric roads. With such an outfit it was found that the average cost per tree for each spraying was 17¼c. Mr Wells, superintendent of streets, is of the opinion that this elevating apparatus is a great saver in time and money. It should be borne in mind, however, that the maple trees at Saratoga were not infested with the elm leaf beetle, but with the forest tent-caterpillar, and that spraying in the case of the latter insect is much easier than in the case of the former, and the cost would therefore be much less.

The work in Albany was done under the civil service regulations, and, owing to local conditions, the foreman was unable to exercise desirable selection in the choice of his men. Mr W. S. Egerton, superintendent of parks, in commenting on the situation remarks as follows: "An active energetic foreman, understanding thoroughly the requirements of the service, and having authority to *select* his men for special qualifications as to handling and climbing ladders and spraying properly, could cover much more territory, more effectually and at much less cost per tree, than the eight hour limit and the civil service regulations permit under the present system." He further remarks concerning the force employed in the operation of the power outfit, which in the city of Albany consisted of a driver, a motorman and two spraying men: "The force used on the motors could, under private enterprise, be reduced to three men to each motor, the motorman and driver being one and the same person and two sprayers, making three operators."

It will be seen by the above that there is an opportunity even with these comparatively low figures to reduce still further the cost of spraying trees without marring the efficiency of the work. The trouble with a great many persons wishing to have spraying done is that they fail to see the necessity of insisting on thorough work, and they are very apt to consider the work cheap if a large number of trees are covered with the poison, whether or not the work be thoroughly done. As a matter of

fact, such work may be very dear, because it may accomplish practically nothing. The public need to appreciate the fact that, unless spraying is thoroughly done, it is better not to attempt any such work.

European willow gall midge, Rhabdophaga salicis Schrk. European willows are used to a considerable extent in and about Rochester and other nursery centers for the purpose of binding nursery stock into small bundles; and any attack made on plantations of young willows is therefore of some economic importance. Mr H. C. Peck called our attention in November 1898 to some galled willows which he found in a small block owned by T. C. Wilson of Brighton N. Y. The insects live in the stems of the willows, and by the production of their galls made them brittle and unfit for tying purposes.

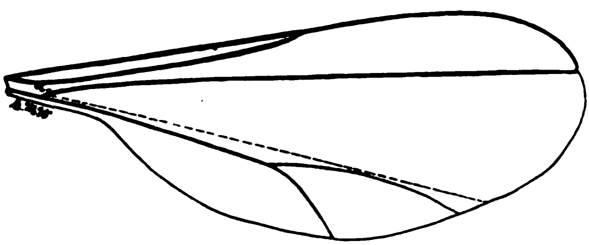

Fig. 14 Venation of Rhabdophaga salicis, much enlarged (original)

Repeated attempts were made to secure the identification of this insect from European authorities but, owing to rough usage and possibly inspections of mail matter, nothing more definite than a generic reference could be obtained, till fresh galls were sent in the spring of 1902 to Prof. J. J. Kieffer, the well known authority on this group, who kindly determined the species. These repeated failures rendered it advisable to characterize the insect, and the following description was in type before the determination was made and it is hoped that this study of a member of the genus Rhabdophaga may prove of value to those interested in this group.

The extreme length of the adult female is about 3 mm. The eyes are black, finely granulated, emarginate anteriorly, confluent in the male and nearly so in the female. The antennae

are 17 jointed and in the male are about the length of the insect. The first joint is subconical, second ovoid and the remainder are pediceled, the pedicel being nearly as long as the enlarged part. The bulb of each segment is irregularly setose, with the hairs as long or longer than the entire segment. Certain of the light dots are connected by lighter strips which appear on focusing to be slightly below the surface of the segment. The female antenna is about one half the length of the insect, the first and second segments being about the same as in the male. There are lines of light dots on each segment much like those recorded for Diplosis setigera Lintn. Each joint is also irregularly ornamented with setae, about as long as the segments, that arise from large, pitlike depressions. The characters of male and female antennae are shown on plate 2, figures 5, 6. The two distal segments are occasionally fused together. The palpi are four-segmented, the two distal joints are nearly equal in length, the basal joint is the shortest and the second intermediate. The thorax is ornamented with two converging rows of silvery hairs, and a short row of smaller ones occurs on each humeral angle, and the metathorax is tipped with a transverse row of the same vestiture. The wings are sparsely covered and well fringed with fuliginous hairs. The venation is represented in figure 14. The halteres are long, slender and tipped with pale yellow. The legs are very long and slender, claws bifid, toothed and with well developed empodium

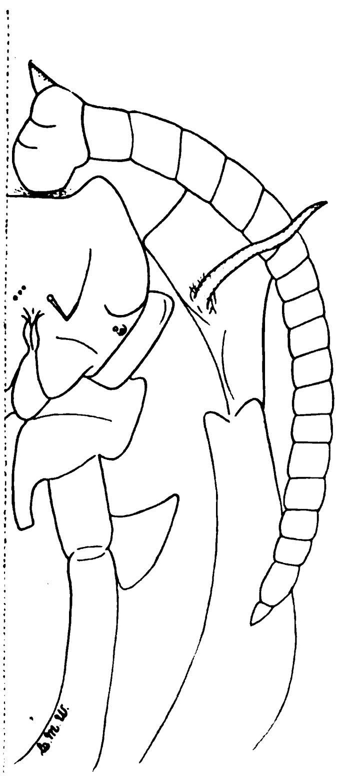

FIG. 15 Ventral aspect of pupal skin of Rhabdophaga salicis, much enlarged (original)

(pl. 2, fig. 3, 4). The distended abdomen of a gravid female is dark red, the color evidently being derived from the contents. The abdomen of the male is nearly black, and the clasps are tipped with two very short, minute teeth.

The puparium is subconical, about 3 mm long, with the anterior two thirds a dark straw yellow and the posterior third a dark rufous.

The cephalic horns of the pupa are pointed, confluent at the base and of a hight equal to their greatest width. The prominent dorsal processes are slender, slightly crooked when observed from the side and with a length equal to about one third of the diameter of the pupa (fig. 15). The slender, setaceous processes are shown at plate 2, figure 2. The pupal mandibles are four toothed, tipped with light brown chitinous and the ventral tooth is nearly twice the size of the one next it which in turn is larger than the others. All curve some and taper to acute points.

The larva is stout, orange red, with 11 easily distinguished segments. It is about $3\frac{1}{2}$ mm long, and the "breast bone," or sternal spatula, is nearly black, enlarged slightly at both extremities and two toothed anteriorly (pl. 2, fig. 1).

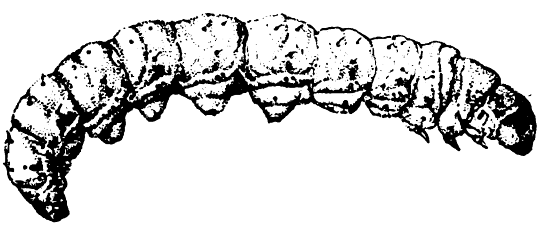

FIG. 16 Caterpillar of carpenter moth (original)

The reddish orange eggs are deposited on the leaves by captive flies in irregular clusters or groups of three to six or more, frequently side by side. They are lanceo-elliptic in outline and about $\frac{3}{10}$ of a mm in length.

This insect produces many celled galls in the stems of small willows. At the time the insects appear, the bark over the infested part turns brown or black and, the pupae working partly through a circular orifice, discloses the imago. The pupal case remains projecting from the gall, and usually there

are enough individuals in one gall to give an empty one a very characteristic appearance on account of the whitish, projecting pupal cases. A gall is represented at pl. 4, fig. 1.

Adult flies were obtained from May 22 onward, from material received on the 10th, and on the 31st a parasite was bred. This was kindly identified by Dr Ashmead of the United States national museum as Tridymus salicis Nees, a species recorded for the first time in America. Tridymus metallicus Ashm. was bred in small numbers from galls received in the spring of 1902 and Polygonotus salicicola Ashm. was reared in numbers. This abundance of parasites leads us to hope that natural agents will soon control this pest. Twigs received June 3, 1901, directly from the willow plantation had disclosed some flies, showing that the period of emergence extends over a number of days. Mr Peck further states that Mr Wilson has been in the habit of opening cases of imported stock near the block of infested willows; so it would be comparatively easy for them to become infested.

Fig. 17 Work of carpenter moth caterpillars, pupal case and adult (original)

Carpenter moth, Prionoxystus robiniae Peck. This is a serious enemy to maple, oak and ash trees in certain sections of New York state. Its destructive work at Ogdensburg was brought to my attention by Miss Mary B. Sherman of that place, and through her some interesting examples of the borers' work in sugar mapletrees were secured. One third of a section of a tree about 15 inches in diameter was fairly riddled with the large burrows of the caterpillar of this insect. It was so abundant as to

ruin a number of fine trees in that locality and necessitate their removal. The work of this pest at Buffalo was brought to my notice by Mr M. F. Adams of that city, and through his kindness I have been able to secure good examples of the insects' work in ash and to observe its operations in oaks. This species also occurs on Long Island. All the examples of its work seen by me show that the full grown caterpillars prefer to run their burrows at some depth in the wood, and that as a rule they run so close to and communicate so freely with one another as to destroy the value of infested trees for timber. This insect also causes large unsightly wounds wherever its burrows come near the surface. Caterpillars about to pupate frequently take refuge in these channeled wounds, from which the pupae work themselves partly out before the disclosure of the imago. The eggs are probably deposited in any available crevice, where they adhere to the bark rather firmly. A piece of root which had been bored by the willow curculio, Cryptorhynchus lapathi Linn., was lying in a breeding cage, and a female Prionoxystus embraced the opportunity to deposit six or seven eggs well within the burrow.

Apparently the females do not hesitate to oviposit before the appearance of males. Some eggs which were found in the office hatched, possibly without being fertilized, but it was impossible to prove the latter point. Dissection of a well distended female which probably had deposited no eggs, showed that she contained 269 well formed ova and 133 which were partly developed, making a total of 402.

Leopard moth, Zeuzera pyrina Fabr. Late in January a communication was received from C. H. Stuart, Newark N. Y., accompanied by an imported quince seedling infested with the larva of this notorious pest. It was stated in the letter that all of the stock with which this stock came would be fumigated before it was set out. This pest, as is well known, has proved and is now a very serious enemy to shade trees in and about New York city; and it is only a question of time when it will become more widely distributed in the United States. It is one

of those forms that can not be controlled by fumigation; and, inasmuch as it is known to have been established in New York city and vicinity for nearly 20 years, it is surprising that it has not spread more rapidly. See pl. 3 for an illustration of the insect and its work.

Birch leaf bucculatrix, Bucculatrix canadensisella Chamb. Last fall the white birches all about Albany were very badly affected by a small caterpillar which ate away the tender, under portion of the leaves. The skeletonized parts dried, turned brown, and the trees looked much as if they had been injured by fire. This year the pest appears to be even more numerous, having been very abundant about Albany. Its work was also observed all through the western two thirds of Massachusetts, and it has been reported as quite injurious in several localities in the northern part of New York. This attack is not unprecedented, though of considerable interest on account of its covering so large a territory. This insect was reported to Dr Lintner as injurious about Scottsville, Monroe co., in 1886, and in 1891 it seriously injured birches about Ausable Forks N. Y.

The parent of this caterpillar is a little, brownish white moth with a wing spread of but $\frac{3}{8}$ of an inch. The caterpillar is a delicate, yellowish green creature about $\frac{1}{4}$ of an inch long when full grown. During the last half of August and the first half of September many can be found curled up under a white, silken covering known as the molting cocoon. Later a beautiful, white, ribbed cocoon will be constructed in which the winter is passed. Pl. 4, fig. 5 illustrates well the appearance of the insect in its various stages.

Valuable trees can be protected by spraying with an arsenical poison, preferably arsenate of lead, taking special pains to get the poison on the under surface of the leaves. It is to be expected that natural agents will soon reduce the numbers of this tiny pest and thus prevent the ultimate killing of the trees.

Golden oak scale, Asterolecanium variolosum Ratz. White oak twigs received from Yonkers N. Y. Sep. 16 were literally covered in places with this insect. The scales

are a little less than $\frac{1}{16}$ of an inch in diameter, nearly circular in outline, strongly convex and varying in color from a light golden yellow to a dark brown. They are usually bordered by a line of white excreted matter, and on badly infested twigs the edges of one scale may overlap those of another. The removal of a scale will reveal a distinct hollow in the bark, showing that

Fig. 18 **Pseudococcus aceris**: *a* adult females on leaf; *b* young female and males on bark. Natural size. (After Howard, *Insect life*. 1894. 7:235)

the growing bark has developed around rather than under the insect. This scale insect has been quite injurious in earlier years to English oaks at Geneva N. Y., apparently doing more harm to large trees.

The young of this scale insect begin to appear in the latitude of Washington D. C. about the first of May, but Prof. Lowe, in his report for the year 1895, states that at Geneva N. Y. the

young had not begun to appear May 29. The young may be expected in the latitude of Yonkers about the middle of May and later; and thorough spraying at intervals of about a week, as long as the young appear, with kerosene emulsion, diluted with nine parts of water, will probably be found very effective in checking this pest. Aim to cover every part of the infested tree with the insecticide.

The small Lecanium nigrofasciatum Perg. has proved a rather serious enemy to soft maples in Albany. This scale insect has been so abundant on some small trees as nearly

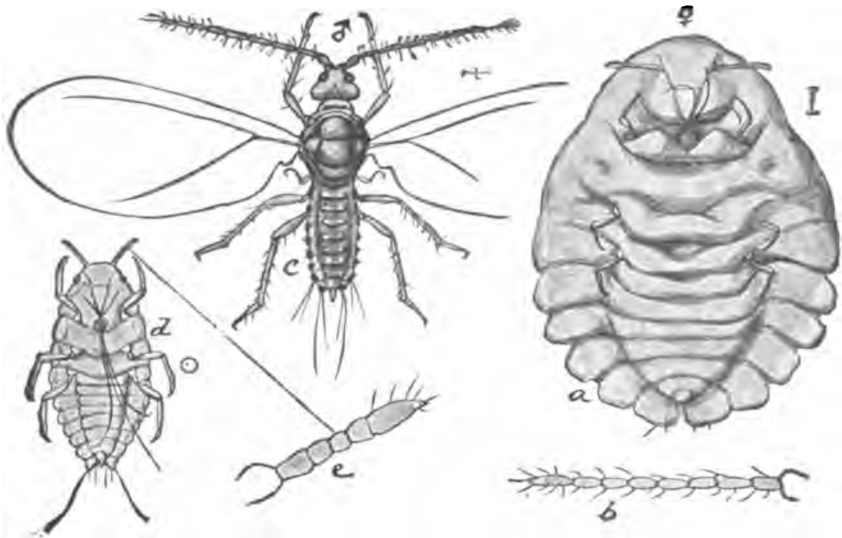

FIG. 19 **Pseudococcus aceris**: *a* adult female; *b* antenna of same; *c* adult male; *d* young larva; *c* antenna of same—*a*, *c*, *d* greatly enlarged; *b*, *e* still more enlarged. (After Howard, *Insect life*. 1894. 7:237)

to cover the under surface of the limbs, and so much honeydew was exuded that the walks beneath were kept moist. The severe drain on the trees prevented much growth and resulted in killing a number of the smaller limbs. Badly infested twigs have a marked sour, semiputrid odor due in all probability to the decomposition of the honeydew. Young began to appear in Albany about June 14, and by July 15 they were about .5 mm long and were thickly set on the smaller twigs (pl. 4, fig. 2).

Pseudococcus aceris Geoff. This comparatively rare species was observed in immense numbers on the bark of a hard maple at Albany N. Y., August 6. It was also observed in considerable numbers on hard maples at Worcester Mass. The male cocoons were present in thousands and in places formed large white masses on the trunk, giving a tree the appearance of being affected by a fungus. Some immature individuals were wandering over the masses of the male cocoons. The leaves were also badly affected. The cottony remains of adults were abundant, and here and there old females were still producing young, as a number of very small individuals were observed, and partly grown ones were assembled on the under surface of the leaf in long rows on both sides of the principal veins. There is a marked, subacid, not unpleasant odor about this species when present in large numbers. It is not nearly so offensive as Lecanium nigrofasciatum Perg.

Chermes pinicorticis Fitch is always more or less injurious to white pines in Washington park, Albany, but this year it has been exceptionally abundant, not only giving considerable portions of the trunk a whitewashed appearance but literally plastering the under surface of many limbs. A number of these pines, as a consequence, have a thin foliage and are sickly. It was also observed in numbers on white pines at Round Lake N. Y.

Garden and other insects

Blister beetles. Several species were brought to notice through the depredations of the adults on various plants. The striped blister beetle, Epicauta vittata Fabr., attacked beets, potatoes, beans and tomatoes about the middle of August, at Valatie, Columbia co. It was reported as very numerous and to have devoured all the beets and tomatoes and then to have attacked potatoes. The exceedingly common black blister beetle, Epicauta pennsylvanica DeG., suddenly attacked sugar beets about the same time at Cobleskill, Schoharie co., and some patches were destroyed. The latter part of August, this species was reported as injurious to potato vines

and China asters at Charleston Four Corners, Montgomery co., the beetles appearing to prefer the half grown aster blossoms.

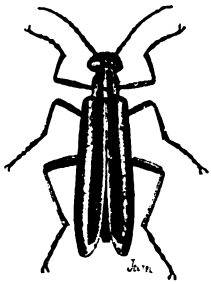

FIG. 20 Striped blister beetle, enlarged (original)

FIG. 21 Black blister beetle, enlarged (original)

The margined blister beetle, Epicauta cinerea Forst., is another common and occasionally a very annoying species.

Owing to the fact that several species of these beetles are known to be beneficial in the grub stage, preventive rather than

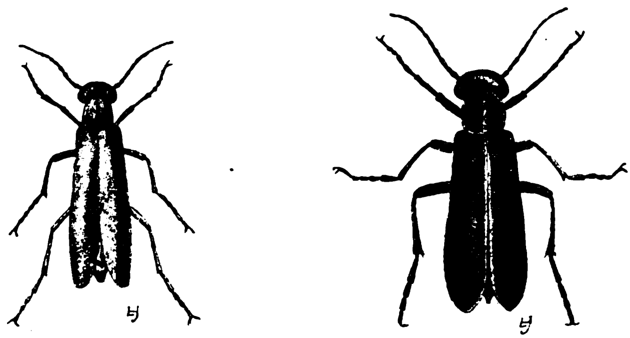

FIG. 22 Margined blister beetle, enlarged (original)

destructive measures have uniformly been urged for their suppression.

Pale striped flea beetle, Systena taeniata. This little pest was very common and quite injurious in an eight acre bean field at South Byron, Genesee co. The field had been sown the previous fall to wheat, which was destroyed in early spring by Hessian fly, and then it was again plowed and planted with beans. The weeds growing in the grain undoubtedly supplied the flea beetles with shelter and provender, and, when they were

destroyed, the insects waited with more or less patience for the appearance of something green. It is well known that this and allied species thrive on weeds, and, while clean culture may not be possible in a grain field, there is rarely a necessity of sowing after grain a crop which these little pests can seriously injure. If such a course be unavoidable, they can be controlled by spraying the plants early with a poisoned bordeaux mixture.

FIG. 23 Pale striped flea beetle, enlarged (original)

Fringed anthomyian, Phorbia ? fusciceps Zett. The bean fields in several parts of the state suffered considerably from the attack of some insect. The trouble was first brought to our attention by J. F. Rose, South Byron, Genesee co., and July 10 a number of fields were visited in his company. A great many bare stalks occurred in several fields, and on investigation it was found that much of the injury of this character must have been caused by a maggot working on the delicate plumule before the plants broke ground and probably before the process of germination had much more than begun. A number of these bare stems were found to be even then infested with dipterous maggots, which were working in the stalks and producing large cavities surrounded by brownish, partly decayed tissues. The species was identified provisionally from larvae taken under such conditions. Unfortunately, we were not able to obtain adults and thus make an authentic determination possible. The greatest injury was observed in a field which had been sown to wheat the previous fall and through the activity of the Hessian fly had been destroyed. This field had been plowed and planted to beans. The reason for greater injury on such fields is probably found in the fact that grain offers abundant food for such insects, and, when this is suddenly destroyed, the insects naturally turn to the most available crop, and in the case of a thinly planted one like beans, serious injuries may result. Newspaper reports mention a similar trouble in Orleans county.

Cacoecia parellela Rob. Moths of this species, kindly identified by Prof. C.H.Fernald, of the Massachusetts agricultural college, Amherst, were bred July 22 to 28 from larvae occurring singly in nests composed of the webbed together terminal leaves of sweet melilot shoots. The caterpillars were quite abundant June 4 to 13 in one small patch of this common weed at West Albany. This species is comparatively new to economic entomology, having so far as known been noticed but twice. It was bred by Dr J. B. Smith,[1] state entomologist of New Jersey, from similar webs occurring on cranberry bushes, and he also observed it on adjacent "loose strife." Larvae of apparently the

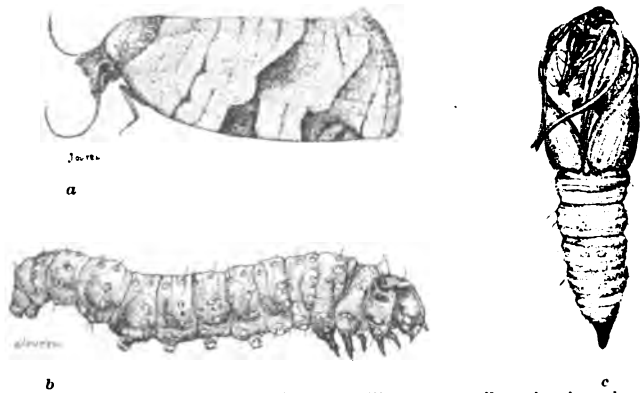

Fig. 24 Cacoecia paralella: *a* moth, *b* caterpillar, *c* pupa, all much enlarged (original)

same species were observed on cranberry near St Anthony park, Minn., by the late Dr Otto Lugger,[2] formerly state entomologist of Minnesota. William Beutenmuller records it as feeding on willow and aster.[3]

As the larvae differ somewhat in color, being characterized as reddish with yellow heads by Dr Smith in his report for 1892, a description is given herewith.

The full grown caterpillar is about ⅞ inch long. Its head and thoracic shield are amber colored. The latter is bordered laterally and posteriorly with irregular black markings and orna-

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[1] N. J. state agric. exp. sta. Rep't 1892. p. 440.
[2] University of Minnesota. Agric. exp. sta. Bul. 61. 1898. p. 283.
[3] Amer. mus. nat. hist. Bul. 4. 1892. p. 80.

mented with a pair of dark spots on the anterior border near the median line. The body is a rather dark green and bears large, whitish, quite conspicuous tubercles, each with one to three hairs or setae. The anal plate is rather prominent and dark brown posteriorly. The true legs are black and the false or prolegs are a yellowish green color. Described from a number of living specimens. The pupal shell is about ½ inch long, brown in color. The cremaster is black and ornamented with about eight or nine recurved hooks.

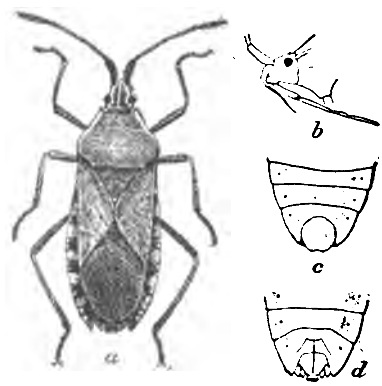

FIG. 25 Squash bug: *a* adult female twice natural size; *b*, *c* and *d* details of structure more enlarged (after Chittenden, U. S. dep't agric. div. ent. Bul. 19, new series)

Squash bug, Anasa tristis DeG. This common and disgusting pest of the squash and other vines has been unusually troublesome and destructive the past season. A number of complaints have been received from various sections of the state. The experience of state botanist Peck may well serve as an example. After an absence of about two weeks, he took 63 adult bugs from four hills of squashes, and two hills had but a single plant each. The squash leaves were fairly covered with eggs, and others were deposited on adjacent raspberry and plum leaves, as well as on cucumber vines.

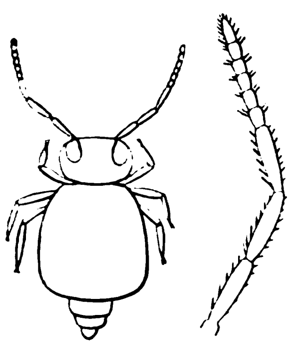

FIG. 26 Garden flea, much enlarged (after Fitch)

Garden flea, Smynthurus hortensis Fitch. Though this insect is said to occur abundantly during May and June in gardens in New York state, it is rarely brought to the attention of economic entomologists. Its small size and quick movements have undoubtedly deterred many from trying to capture it, but this difficulty was ingeniously solved by Mr C. E. Ford, Oneonta N. Y., who

smeared molasses on a piece of cardboard, gummed it in the bottom of a small box and, while the molasses was still fresh, clapped it over the insects. Their jumping brought them into contact with the sticky surface, and there they remained secure and alive till they reached the office. Mr Ford stated, under date of May 31, that this species was particularly injurious to melon and squash vines. The general form of the insect, though much enlarged, is shown in the accompanying figure. It is a broadly oval, black or dark colored insect less than $\frac{1}{10}$ of an inch in length, wingless but provided with short, thick hind thighs and also a peculiar, ventral springing fork. The latter structure is peculiar to insects belonging to the same order, Thysanura, and it is on account of this peculiar organ that these insects are frequently known as "springtails." Dusting affected plants thoroughly with plaster or ashes or, better still, spraying them with a poisoned bordeaux mixture should control the pests.

Rabbit botfly, Cuterebra ?cuniculi Clarke. This species, closely related to the "warble fly" of cattle, which is frequently known as "grub-in-the-back," was twice brought to notice during the season—once, when infesting Belgian hares, and in this instance the identification was in all probability correct. The second case was that of a kitten four months old, owned by D. F. Meskil of Highland Falls N. Y. The history of the case as stated by Mr Meskil is as follows. About Aug. 7 the kitten "developed an abrasion on his side, midway between the hind and fore quarters and 1 inch below the spine. It rapidly developed into a suppurating protuberance," and by the 16th it was "an inch and a half long and as thick as a man's thumb." It will be noted that this is just about the position where this larva develops on the rabbit. The sore was cut open, and a grub $\frac{7}{8}$ of an inch long and nearly half an inch in transverse diameter removed. The grub resembles the one from the Belgian hare very closely, and they probably belong to the same species. It only remains to add that the kitten recovered rapidly after the removal of this disgusting pest. The accom-

panying figure gives a very good idea of the appearance of this grub. An examination of one, with even a common hand lens, will show that its dark brown color is due to a multitude of pointed, chitinous pyramids, which literally cover the nearly white skin, and one has only to imagine such a creature working about in a sore, to obtain some idea of the pain inflicted. The parent fly is about the size of a bumblebee and much resembles that insect. It has a black head, yellow brown hairs on the dorsum of the thorax, yellow hairs on the first segment

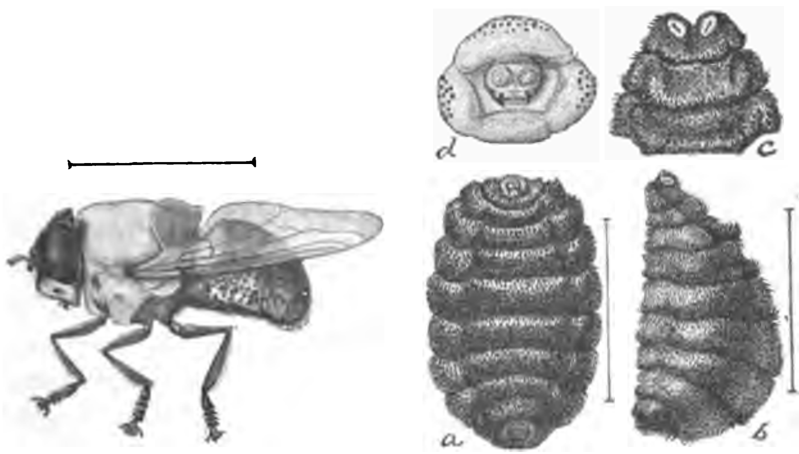

Fig 27 Cuterebra cuniculi: side view; *a* larva, ventral aspect; *b* pupa, lateral view; *c* anterior extremity; *d* hooks and anterior spiracles of larva — all enlarged. (After Osborn, U. S. dep't agric. div. ent. Bul. 5, n. s. p. 109)

of the abdomen and the remaining segments of a blue-black color. It is represented in the accompanying figure.

European praying mantis, Mantis religiosus Linn. This beneficial insect was discovered by Mr Atwood in 1899 at Rochester N. Y., where it had undoubtedly been brought on imported nursery stock. Several notices of the introduction of this insect have been published by Prof. M. V. Slingerland, who has also issued an interesting bulletin[1] on this species. It has now become quite abundant in Rochester, and last spring an effort was made, through the kind cooperation of Mr Atwood, who sent 227 egg clusters, to introduce this beneficial insect into

[1] Cornell univ. agric. exp. sta. Bul. 185.

other parts of the state. Seven to eight egg clusters from this lot were sent to the following persons: C. L. Allen, Floral Park, H. S. Ambler, Chatham, M. H. Beckwith, Elmira, R. L. Darrison, Lockport, O. Q. Flint, Athens, S. H. French, Amsterdam, J. T. Gaylord, Poughkeepsie, G. S. Graves, Newport, W. G. Hitchcock, Pittstown, S. B. Huested, Blauvelt, H. D. Lewis, Annandale, E. H. Mairs, Irvington-on-Hudson, L. L. Morrell, Kinderhook, Paul Roach, Quaker Street (Schenectady co.), E.T. Schoonmaker, Cedar Hill, C. H. Stuart, Newark, Franklin Taber, Poughkeepsie and C. L. Williams, Glens Falls. Each lot was also accompanied by a letter directing the recipient to keep the eggs cool and as soon as possible to tie them to the stem of some bush or to a low branch of a tree. The persons were requested to keep watch for the hatching of the eggs and to report concerning them. A copy of Prof. Slingerland's bulletin was also sent to each. In addition, a number of egg clusters and a few living young were distributed about Washington park, Albany, some in the northeast and a number near the northwest corners of the main part of the park; 15 egg clusters were distributed May 22 about the premises of H.A.Unger, Hillview, East Greenbush; and about as many June 8 in the gorge below Dean's mill, Coeymans N. Y. A number of egg packets were taken to Saratoga N. Y. May 4, a few placed in promising locations, and others given to the street, water and gas commissioners of that village.

It is naturally somewhat difficult for one unfamiliar with this insect to be certain that young mantids hatched from the eggs, and in the majority of instances negative results have been reported. Still it is well to have these localities on record because some of the insects may have escaped unobserved. Mr G. S. Graves of Newport states that during the summer a Mr Morey found one dead adult in a whey vat and a living specimen in the house. They were identified by comparing with an illustration in a dictionary. Mr O. Q. Flint, Athens, reports that some of the egg masses looked as if they had hatched. W. C. Hitchcock, Pittstown, states that he found one freshly laid egg mass. R. L. Darrison, Lockport, succeeded in obtaining between

July 2 and 5, 100 young mantids from an egg mass kept indoors. The young were set at liberty in the vicinity. None of the egg masses put out of doors developed any insects, Mr Darrison states. Messrs Allen, Ambler, Beckwith, Huested, Morrell, Roach, Schoonmaker, Stuart, Taber and Williams reported negative results. J. T. Gaylord of Poughkeepsie was unable to find any young mantids or to discover recently deposited egg clusters; but E. H. Austin of Gaylordsville Ct., to whom he sent a few eggs, discovered several living mantids about an inch or so in length. H. D. Lewis of Annandale found several fresh egg clusters, some of them over 100 rods from where the eggs were planted last spring. This insect should have become established in Albany or its vicinity, but up to the time when this report is submitted, nothing very encouraging has been discovered. Apparently, quite a proportion of the egg clusters failed to hatch, though a number of the young were obtained in the office.

Croton bug, Phyllodromia germanica Linn. An excellent remedy for this household pest was reported on last May by Mrs H. D. Crane, Montclair N. J., who found powdered borax to be the best of a number of substances tried. She states that it must be used freely all around the cracks and corners and so placed that the bugs can not get to water without going over it. Her neighbors also had excellent success with this substance. This insect is such a serious pest in some houses that records like the above should be given wide circulation for the encouragement of others. As noted in earlier publications, Hooper's fatal food has also been used very successfully. There are probably other equally good proprietary remedies, but nonpoisonous ones should receive preference about houses.

Unusual abundance of southern forms

A study of climatic conditions is not without value, since it gives a basis for forecasting the probability of insects being able to live in various sections of the country. This is of considerable importance in the case of injurious and beneficial

species, because we are thereby able to ascertain to some extent the limiting agencies controlling them, and the more that is known along these lines concerning various forms, the more accurate will be our judgment as to their possible range. The present year has been marked by the presence in abundance of several interesting species, three of which are mentioned below. The reason for their occurrence in great numbers is probably found in unusually favoring weather conditions, particularly in the more than normal warmth. A study of the monthly mean temperatures during the growing season in the Hudson river valley for this and the preceding four years bears out this conclusion somewhat. The following tables, compiled from the records of the New York state weather bureau and from those of the New York section of the national weather bureau, show this fairly well.

Monthly mean temperature of the Hudson valley region

	May	June	July	August	September
1897.............	59	64.3	73.0	68.6	61
1898.............	57.3	68.8	73.7	71.8	65.9
1899.............	59.7	70.3	72.1	70.8	61
1900.............	58.1	69.2	74.1	73.3	66.1
1901.............	57.6	69.1	74.7	71.4	63.2

June in 1899, 1900 and 1901 was markedly warmer than in 1897 and 1898 and July in both 1900 and 1901 was warmer than the same month in 1897, 1898 and 1899, and this higher temperature is more marked in August 1900, which is just about the time of year when many insects would respond most readily to the influence of heat, specially those in the caterpillar stage, and the more than normal warmth would tend to produce greater vigor than usual in this latitude and a consequent increase in numbers the present year. The increased warmth of the last two years is still better shown in the table of monthly means of Albany, compiled from the same sources as the preceding table.

Monthly mean temperature of Albany

	May	June	July	August	September
1897.............	59	65	75	70	63
1898.............	58.2	69.8	75	73	60.6
1899.............	60	71	73.2	72.3	61.4
1900.............	57.9	70.5	74.6	74.7	67.7
1901.............	59.1	70.2	75.8	72.8	65

It will be seen that June of 1899-1901 was distinctly warmer than in the two preceding years, and, while no other months show as marked difference in mean temperatures, even this means a considerable increase in warmth for the season when accompanied by no corresponding decrease in other months. It is also worthy of notice in this connection that July 1901 was exceptionally warm, as compared with preceding years.

Cicada killer, Sphecius speciosus Drury. This handsome, black, yellow marked wasp has been relatively quite abundant about Albany the last summer. A few specimens were taken in the city and at Karner, 7 miles west, it was abundant about scrub oaks, where it appeared to be feeding on the sap

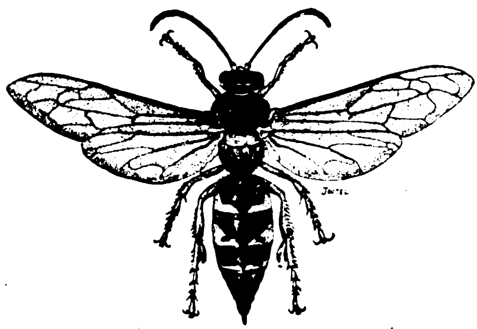

Fig. 28 Cicada killer (original)

exuding from some of the buds. This insect has previously not been recorded so far north, not being known to occur in the Hudson river valley above the vicinity of Poughkeepsie. Its presence and abundance are probably due largely to the more than normal warmth of the last year or two.

Giant swallowtail or orange dog, Heraclides cresphontes Cram. The larvae of this giant butterfly were unusually abundant last summer. They were sent to the office from Athens, Greene co., Selkirk and Albany, Albany co., Schoharie, Schoharie co., Albion, Orleans co., and Batavia, Genesee co. The report from Batavia states that this insect is something entirely new to that locality. The caterpillars must have been quite abundant at Schoharie, as about 200 were taken from

common "rue" and from fraxinella, and a shrub full of "thousands" of smaller ones was also reported. This caterpillar may attain a length of 2½ inches. It is curiously mottled with shades of brown and with two large silvery white patches, one near the middle of the caterpillar, and the other at its posterior extremity, giving it a peculiar, blotched appearance, and making it resemble somewhat the droppings of a bird. It is well represented, with its reddish, fetid osmeterium extended, as is the case when it is annoyed or alarmed, in the accompanying figure.

The above records are in marked contrast to those of pre-

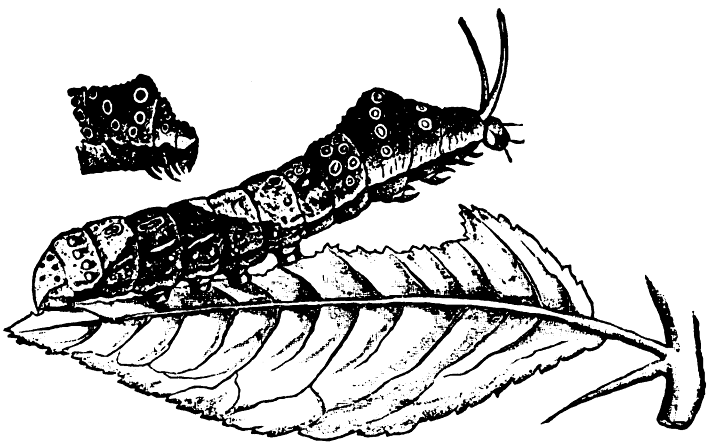

Fig. 29 Orange dog or caterpillar of Heraclides cresphontes

vious years, the presence of this species in the state having been reported directly to the office but twice before, according to published records, once last year, when our attention was called to its occurrence on fraxinella at Altamont, and again in 1892, when it was sent to the late Dr J. A. Lintner from Glen Cove L. I., with the statement that the caterpillars were numerous on Choisya ternata. Dr Lintner, commenting on this insect in his report for that year,[1] makes the following statement:

Papilo cresphontes is a southern species ranging from the northern part of South America northward. It has gradually extended its range until now it occurs as far north as

[1] N. Y. state ent. 9th rep't. 1892. p. 337.

Montreal in Canada. The first record of its appearance in the state of New York was in 1864. Within late years, from being an occasional visitor, it seems to have established itself in Westchester county, and at Poughkeepsie. In other localities in the state it is occasionally abundant, as in Rochester, where, according to Mr Bunker, it "swarmed" one season, several years ago. Prof. L. M. Underwood has written me that on Sep. 12, 1882, he saw several examples flying over the low swales near the Rhinebeck and Connecticut railroad in Columbia county. It has not been observed in the neighborhood of Albany. A single example was taken at New Baltimore, 17 miles south of Albany, in the month of September.

Rose scale insect (A u l a c a s p i s r o s a e Sandb.) This destructive southern species was found June 3 in abundahce on blackberry bushes at Hudson N. Y. The young were appearing in considerable numbers at this time. It was breeding in large numbers on cuttings from a crimson rambler rose brought from Cobleskill N. Y. Oct. 18. Adult female scales were abundant and several parasites, A r r h e n o p h a g u s c h i o n a s p i d i s Aur. were observed crawling on the twigs. This scale insect was also sent in on raspberry plants from Cornwall N. Y. This is a species which is brought to attention at infrequent intervals in this state. One reason for this may be found in its general resemblance to the exceedingly common C h i o n a s p i s f u r f u r a Fitch, and it is not at all unlikely that many after a glance have concluded that the scale on the raspberry or blackberry was the scurfy bark louse and therefore not pushed the inquiry further. The species is represented on pl. 4, fig. 3, 4.

EXPERIMENTAL WORK AGAINST THE SAN JOSÈ SCALE INSECT

The tests of various insecticides begun last year were continued in the same orchard during the present season, and in the main the results in 1900 were confirmed, and our confidence in a mechanical crude petroleum emulsion much increased. The chief aim of experimental work along this line is to make comparative tests of various insecticides, and naturally some of the substances used are not so effective as one might desire; yet, in spite of that drawback, the experimental orchard is in much

better condition than it was two years ago. It is only necessary to compare pl. 5, 6 to obtain a relative idea of the value of spraying for San José scale. The experimental orchard was the first in that vicinity to become infested with the San José scale; and two years ago it was composed of a very bad-looking lot of young trees. Today the conditions are reversed, so far as these two orchards are concerned, and the later infested, near by orchard is in much worse shape than the other. It is true, that the former is composed of appletrees set a considerable distance apart, and that naturally makes the orchard look thin compared with the more closely set peachtrees and peartrees, but a close examination shows that the true relative condition of the trees is very fairly expressed in the two plates.

The poor results obtained from early spring applications of kerosene and mechanical emulsions of the same in 1900, led to the concentrating of the work on the more promising insecticides, namely, crude petroleum and whale oil soap in various combinations. Two crude petroleums were used, care being taken to make field tests of the oil just before spraying, consequently there can be no doubt regarding its weight as determined by the hydrometer. One of the crude petroleums used was obtained from a local oil dealer handling the products of the Standard oil co. This is a quite fluid, greenish oil, and it gave a field reading of 41.8° Beaumé. It was presumably about the same as that used last year, as it appeared no different and was obtained from the same source. The other crude petroleum was received directly from the Frank oil co., Titusville Pa. This was of a light amber color, and it was said to test from 44° to 45° on the Beaumé oil scale. In the field it gave a reading of 43.3° Beaumé. Both of these tests were made at a temperature of about 65° F. These two crude petroleums, for the sake of brevity, have been characterized in our records as Standard oil and Titusville oil respectively, and these names will be used in the following pages. Comparative tests of mechanical emulsions of both these oils were made, and the results are given below. The spraying was done April 11, which was bright, with at times a rather strong wind.

Substances experimented with. Crude petroleum was tested on a large number of trees, both the Standard and the Titusville oils being used in 20% and 25% mechanical emulsions, and the latter was also used undiluted on a few trees. Good's whale oil soap no. 3 in a solution of 1 pound to 4 gallons of water was used with 10% and 15% Standard oil, the kerowater sprayer being employed, as last year, in making a mechanical combination between the soap solution and the oil. Good's whale oil soap was also used by itself at the rate of 2 and of 1½ pounds to the gallon.

Time and methods. The apparatus, the hand kerowater spraying outfit, was the same as employed last year. The experiments were all in the same orchard, for a diagram of which the reader is referred to pl. 3 of the preceding report. It was undesirable to treat all the trees with the substances used on them in 1900; and it will be seen by consulting the diagram, that the different insecticides have been applied to transverse sections of the orchard. This did not always permit of applying the same preparation to several varieties of pears and peaches, but, on the other hand, it was much easier to keep track of different tests. The numbers bestowed on the trees in 1900 have been retained, and it is thus very easy to ascertain the previous history of any tree by consulting the preceding report.

Supplementary notes. There are several observations which, though not strictly a part of the experimental work proper, may as well be recorded in connection with it, since they were noted in the progress of the work. The young of the San José scale were abundant on trees in the experimental orchard July 3, 1901, and, as there were a number of young in the black stage, they must have begun to appear about a week before. Sep. 25, young were crawling in considerable numbers on relatively few trees, and the same condition was observed Oct. 15. Thus this period agrees with those observed in preceding years, and the breeding season may be said to extend from the latter part of June through October.

There is a brief mention of the occurrence of the little black ladybug, Pentilia misella Lec., in my previous report,[1] but this year it was observed in much larger numbers on infested trees in the experimental orchard and also in an infested orchard near by. It was much more abundant in the latter, probably on account of the much larger number of scale insects, since practically nothing had been done to keep the pests in check. This beneficial form was not present in sufficient numbers to attract notice till Sep. 25, and from then till the middle of October, at least, the beetles were quite numerous; 50 on a small badly infested tree would not be an excessive estimate. These ladybugs, however, do not seem to have made much impression as yet on the San José scale; and, though they were much more abundant in the adjacent orchard where no insecticides of any account had been applied, the scale had not been affected enough to warrant a hope that eventually this pest may be controlled by this little natural enemy. It certainly would not be wise at present to defer treatment with insecticides on account of the presence of this tiny ladybug.

The fruit tree bark beetle, Scolytus rugulosus Ratz., also occurs in the experimental orchard, attacking a number of trees last year but injuring only one very seriously. This was broken down by wind or other agency, and the beetles entered the prostrate limbs in large numbers. This year a light oxheart cherry (tree 4) was attacked by this beetle and injured considerably. It was in excellent condition last year, but toward the end of the season became rather badly infested with San José scale. July 3 it was found to be infested with Scolytus. There was a copious exudation of sap or gum and a number of edematous swellings were observed here and there. The tree was quite badly affected Aug. 9. Several other trees were attacked to a less extent by this borer.

Appearance of oil on trees. This general note applies to all trees treated with crude petroleum or mechanical emulsions of the same. May 22, the oil shows very plainly, and all of the

[1] N. Y. state ent. 16th rep't. 1901. p. 970.

trees appear to have been in a very good condition, except where dead twigs are recorded in the following notes, and this is more likely due to injury by the San José scale or winterkilling from some other cause, than from the application of insecticides, either this or the previous year; since it is about as common on trees treated with whale oil soap as on those sprayed with crude petroleum.

Standard oil, 20% mechanical emulsion. 11 trees were treated with this combination. They are as follows: tree 115 a Bartlett and trees 24, 110 and 111, Kieffer pear; tree 25, a beurre bosc; trees 70 and 71, respectively Clapp's favorite and beurre d'Anjou pears; trees 43, 44, 88 and 89, old Mixon peach. The condition of these trees was as follows toward the close of the growing season, Sep. 7, 1900. There were very few or no young scale insects on trees 24 and 115; no living young were found at that time on tree 111, very few on tree 110, but few on trees 25, 43 and 44; living young were very abundant on trees 70, 71 and 88, specially on tree 71, and they were extremely abundant on tree 89.

The first observations, made after the spraying of Ap. 11, were on May 22, when only those trees presenting something out of the ordinary received special attention. Tree 71 had then only one vigorous shoot, and tree 88 had been cut down to a five foot stump, from which a few buds were breaking forth.

July 3, a date which was late enough to permit a fair judgment of the numbers of living scale insects, through the abundance of the young, the conditions were as follows. There were few or no young on trees 24, 25, 43, 88, 110, 111 and 115; young were rather few on tree 44 and few on trees 70, 71 and 89. The following additional notes were made at this time regarding the condition of certain of the trees. The new shoots on tree 25 were vigorous, and the cluster of shoots on tree 88 were short and vigorous. The bark of tree 70 was very rough.

Aug. 9 very few or no young scale insects were to be found on any of these trees. The shoots on tree 88 were growing very fast.

Sep. 25, there were very few or no young scale insects on trees 24, 25, 71, 88, 89, 110 and 111; and young were relatively few on trees 70 and 115.

The above record, it will be observed, shows that with only one application in a year, the San José scale was kept in control in a very satisfactory manner, with the exception, perhaps, of trees 70 and 115. The former was very badly infested in the spring of 1900, and, while the treatment with whale oil soap controlled the pest to a great extent, living young were very abundant on it in September 1900. Its bark was very rough, and this with the old scales would serve as a considerable protection to the young, and it is not surprising that some survived the spraying of 1901. It is by far the worst tree in this lot. Tree 115 is exceptional in that it was located on the edge of an old orchard, where it could become infested from neighboring trees.

Standard oil, 25% mechanical emulsion. 7 trees were treated with this mixture. They are as follows: tree 21, a Howell, and tree 106, a Vermont beauty pear; trees 38, 83 and 84, globe peach; tree 40, a Crawford and tree 85, an old Mixon peach. The condition of these trees toward the close of the growing season, Sep. 7, 1900, was as follows. Young scale insects were very few on trees 83 and 84, few on trees 85 and 106, abundant on tree 21, very abundant on tree 38, and exceedingly so on tree 40. Trees 39, 66, 67 and 107 also belonged in the area treated with this mixture, but all of them were cut back to mere stumps in 1900, and they were removed in the spring of 1901.

May 22 the following notes were made on trees presenting an appearance out of the ordinary. There were only a few small limbs alive on tree 40, and a number of small limbs had been winterkilled on tree 83. Tree 106 was thickly set with fruit.

July 3, the following conditions were apparent. There were very few or no young scale insects on trees 38, 40, 83, 84 and 106; they were few on tree 21, and rather abundant on tree 85. It was noted that the bark was quite rough on trees 21 and 66, which undoubtedly explains why young scale insects were present on these trees, as it is practically impossible to kill all the

individuals with a spray when the bark offers numerous sheltering crevices.

Aug. 9 there were few or no young scale insects on trees 38, 40, 83, 85 and 106, few on trees 21 and 84, and rather few on tree 66.

Sep. 25, the following conditions prevailed. There were very few or no living scale insects on trees 83 and 106, very few on trees 84 and 85, few on trees 38 and 40. Young scale insects were rather abundant on some twigs of tree 21, but its general condition was very good considering its previous history.

This record is apparently not so satisfactory as in the case of the smaller per cent of oil. Allowance should be made in the case of trees 21, 38 and 40. The first was in exceedingly bad shape in the spring of 1900, and, while spraying with undiluted kerosene killed many of the scales, so many were left that the tree was abundantly infested the following September. The scraggy, rough condition of the tree, in my opinion, amply accounts for the failure to kill all the scale insects last spring. Trees 38 and 40 were sprayed with 20% kerosene in 1900, and the abundant scales on them in the spring of 1901, together with the very rough bark of tree 38, would afford ample shelters for the escape of a few. The very few living scales found on trees 84 and 85 in September 1901 could easily have been brought from adjacent trees, though one or two individuals may have escaped the spray.

Titusville oil, 20% mechanical emulsion. There were 14 trees treated with this mixture. They are as follows: trees 26 and 27, Kieffer; trees 28 and 114, seckel; tree 72, Flemish beauty; tree 73, Howell; tree 74, beurre bosc; trees 112 and 113, beurre d'Anjou pears; trees 45, 47, 90 and 91, old Mixon peach; and tree 46 a champion quince. Their condition near the end of the growing season, Sep. 7, 1900, was as follows. There were few or no young scale insects on trees 26, 27, 112, 113, few on trees 45, 46, 74 and 114; they were rather abundant on trees 47 and 73, abundant on tree 28, and very abundant on trees 90 and 91.

The first examination after spraying occurred May 22, and only those trees presenting something out of the ordinary were

noted. Many small limbs were dead, probably winterkilled, on trees 47, 90 and 114. A large dead limb had been cut off of tree 45, the tops of trees 47 and 90 were thin, and all that remained of tree 72 was a stub with vigorous suckers.

July 3, the following conditions were noted. There were very few or no young scale insects on trees 26, 27, 46, 47, 72, 90 and 113; very few young were found on trees 74, 112 and 114; few young were found on tree 28; young were rather abundant on tree 45, and abundant on tree 73. At this time the sprouts on tree 72 were growing slowly.

Aug. 9, the conditions were as follows. There were very few or no young on trees 26, 27, 45, 46, 47, 74, 90, 91, 112, 113 and 114; young were rather abundant on tree 28, and abundant on tree 73. Tree 72 was represented only by a stub at this time.

Sep. 25, the following conditions prevailed. There were few or no living scale insects on trees 26, 27, 46, 47, 91 and 113; there were very few on tree 28; few on trees 45, 72 and 90; relatively few on trees 74, 112 and 114; and they were very abundant on tree 73.

The condition of this lot of trees Sep. 25 was fairly satisfactory if we except tree 73, and the occurrence of abundant young on this can be explained only by the probability of a number of insects being so sheltered by the very rough bark that the spring application of petroleum did not reach them. The presence of a few scale insects at the end of the season on trees 45, 72 and 90 is not surprising, considering that they could have easily become infested from other trees, even if all the living scale insects on them at the time of the treatment had been killed by the petroleum. The occurrence of more living scales on trees 74, 112 and 114, all of them located on the extreme edges of the orchard and in positions where they would be most likely to have the pest carried to them by birds and other insects, gives additional weight to the opinion that the results produced by the various insecticides have been modified during the growing season by the conveying of crawling young scale insects to the trees by various natural agents. A very

good proportion of the trees in this lot are practically free from San José scale.

Titusville oil, 25% mechanical emulsion. There were 10 trees treated with this mixture. They are as follows: trees 22, 23 and 69, Howell; tree 68, a Vermont beauty; tree 108, a Bartlett; tree 109, a beurre bosc pear; trees 41 and 86, Crawford; and trees 42 and 87, old Mixon peach. Their condition near the end of the growing season, Sep. 7, 1900, was as follows. There were very few or no young scale insects on tree 86; few on trees 42 and 109; they were rather abundant on trees 41 and 87; abundant on trees 22, 23, 69 and 108, and exceedingly abundant on tree 68.

May 22, there were only a few upper limbs living on trees 86 and 87.

July 3, there were very few or no young scale insects on trees 41, 42, 86, 87 and 109; there were few on trees 22 and 69; they were rather abundant on tree 23, and abundant on trees 68 and 108.

Aug. 9, there were very few or no young on trees 41, 42, 87 and 109; and they were rather abundant on trees 23, 68, 69 and 108. Tree 86 was dead.

Sep. 25, there were very few or no young on trees 69, 87 and 109, few on trees 41 and 42, rather few on trees 23 and 108; and they were rather abundant on trees 22 and 68. Tree 87 was then a mere stump.

A study of the above record in connection with the diagram of the orchard shows that, of the six trees on which living San José scales were found Sep. 25, three were on the extreme edges of the orchard and therefore very liable to become reinfested during the season. In addition, it should be noted that two of these three trees, nos. 22 and 23, were very badly infested in the spring of 1900, and in the fall of that year living scale insects were abundant on them. The bark on these trees was also very rough. Of the other three, there were only a few living scales on trees 41 and 42, and the remaining interior tree, no. 68, which has a very rough bark, was very badly

infested in the spring of 1900 and abundantly so the following autumn. This is certainly not a very bad showing for this oil.

Crude petroleum, undiluted Titusville oil. The disastrous results obtained with this substance last year acted as a check to more extensive experiments this season. It was decided to test in a small way some of the crude petroleum received from Titusville Pa., because, according to certain published accounts, it would not harm the trees. A description of its physical properties is given on p. 762. Three trees were sprayed with this substance. Tree 20, a Bartlett pear, was very badly infested with the scale in 1900, and it was selected among others, for treatment that spring with undiluted kerosene. It was in a very bad state to begin with, and last October even the suckers from this tree appeared to be in an unhealthy condition. It was sprayed Ap. 11, 1901, with this crude petroleum. It developed no leaves the present season, and it was probably nearly dead before the petroleum was applied. Tree 116 was a Lombard plum which was very badly infested with the San José scale, but, as the infestation was comparatively recent, and as the tree had received no previous application of an insecticide, it was a very good subject to experiment on. The oil was sprayed on the tree rather liberally Ap. 11, and July 3 it was seen that several limbs were seriously injured and dying, and that some of the others gave indications of feebleness. Aug. 9, this tree was dead, the result, undoubtedly, of the application of the oil. Less oil would probably have been less injurious, but the fact remains that this so called safe oil is not necessarily so. The third tree was Crawford peach, which was very badly infested with San José scale, and, like the preceding, it had not been treated with any insecticide. The scales were so abundant as literally to cover most of the trunk and the larger limbs, and in some places they appeared to be two or three deep. This tree developed no leaves, and it was probably very seriously injured by the scale infestation. Its death can hardly be attributed to the application of the oil.

Good's whale oil soap no. 3 and 10% petroleum. The Standard oil was used in these experiments. There were 12 trees treated

with this compound. They are as follows: trees 18 and 63 are an early unnamed pear; trees 19, 64, 65, 104 and 105 are Bartletts; tree 103 is an Idaho pear; trees 36, 37, 81 and 82 are globe peach. The condition of these trees near the end of the growing season, Sep. 7, 1900, was as follows: there were very few or no young scale insects on trees 18, 19, 82 and 104, very few on trees 63, 81 and 105, few on tree 103; they were abundant on tree 36, and very abundant on trees 37, 64 and 65.

May 22 it was seen that many of the tips of the smaller limbs on tree 37 had been winterkilled, and that tree 82 had suffered in this way to some extent.

July 3, there were very few or no young scale insects on trees 36, 81, 82, 103, 104 and 105, few on trees 18, 19, 37, 63 and 65; and they were rather abundant on tree 64, which has a rough bark.

Aug. 9, there were few or no young on trees 18, 36, 37, 63, 81, 82, 103 and 104, few on trees 19, 64 and 105, and they were rather few on tree 65.

Sep. 25, there were very few or no living scale insects on trees 63, 64, 65, 81, 104 and 105, very few on trees 18, 19 and 103, and but few on trees 36, 37 and 82.

The record for this substance is very good. Three of the trees having very few living scale insects on them at the end of the season were on the edges of the experimental orchard, where they could easily have become reinfested. Living scale insects were abundant and very abundant, respectively, on trees 36 and 37, while tree 82 was very badly infested in the spring of 1900, and, though very few were found on it at the end of that season, some might easily have escaped the second treatment under the shelter of old scales.

Good's whale oil soap no. 3 and 15% petroleum. The Standard oil was used in these experiments. This combination was tested on 13 trees. They are as follows. Trees 15, 16, 60, 61 and 101 are seckel; trees 17 and 62, an early unnamed variety, and tree 102, a beurre bose pear. Trees 34, 35, 79 and 80 are globe peach trees; tree 34a, a natural sprout. Their condition near the end

of the growing season, Sep. 7, 1900, was as follows. There were very few or no young insects on trees 60, 61, 79, 101 and 102, very few on tree 80, few on trees 16, 17 and 62; they were rather abundant on trees 34, 35, and numerous on tree 15.

May 22, very few limbs were winterkilled on trees 34, 35 and 80, and there were a number of dead limbs on tree 101.

July 6, there were very few or no young scale insects on trees 34, 34a, 62, 80, 101 and 102, very few on trees 17, 35, and 79, few on trees 16 and 60; they were rather abundant on tree 15, and abundant on tree 61. The bark of tree 61 was very rough, and the sprouts on tree 101 were rather thrifty.

Aug. 9, there were few or no young on trees 17, 34, 34a, 35, 60, 62, 79, 80, 101 and 102; they were rather abundant on trees 15, 16 and 61.

Sep. 25, there were few or no living scale insects on trees 34, 62 and 101, very few on trees 15, 16, 17 and 102, few on trees 34a, 35, 60, 79 and 80; they were rather abundant on tree 61.

The general condition of this lot of trees Sep. 25, 1901, is very fair. Living insects were found on three quarters of the total number, but not in considerable numbers, except in the case of tree 61, which was very badly infested in the spring of 1900, and its rough bark undoubtedly accounts to a large extent for the poor success in controlling the pest in this instance. The very few on trees 15, 16, 17 and 102 might easily have been carried to them by natural agents, since they are on the edge of the orchard near adjacent, untreated trees. In the case of the remaining infested trees, nos. 35, 60, 79 and 80, while they may have been reinfested, it is very probable that in each instance a few insects escaped the spray.

Good's whale oil soap, no. 3, 1½ pounds to the gallon. This strength was used on 24 trees. They are as follows. Tree 3 is a light oxheart, tree 4, a wild cherry, and tree 4a, a plum 5 feet high. Tree 6 is a Crataegus. Tree 75 is a Crawford, and tree 29 is a globe peach. Trees 7, 9, 51, 52, 53 and 92 are botan; tree 8 is a Lombard; tree 49, an abundance, and tree 95, a golden drop plum. Tree 54 is a nectarine. Trees 10 and 55 are beurre

bosc; trees 11, 56 and 57 are seckel; tree 50, an Idaho, and tree 96 a beurre d'Anjou pear. Tree 48 is a crab apple. The condition of these trees near the close of the growing season, Sep. 7, 1900, was as follows. There were very few or no living scale insects on trees 5, 6, 29, 48, 49, 55 and 56, very few on trees 75 and 97, few on trees 7, 30 and 96; they were very abundant on trees 3 and 50 to 53, and extremely abundant on trees 8 to 11.

May 22, tree 5 was just beginning to bloom, though it had been partly uprooted by the wind. Trees 9 and 10 had set considerable fruit. Trees 52 and 53 were winterkilled to some extent, and the same was true of tree 92. Trees 93 and 94 had died from the applications of the previous year, and had been removed.

July 6, there were very few or no young scale insects on trees 4a, 7, 7a, 11, 29, 30, 48, 55, 75, 96 and 97, few on trees 51 and 56; they were rather abundant on trees 4, 9, 10, 52, 53, 92 and 95, and very abundant on trees 8 and 50. There was considerable dead wood on trees 52, 53 and 92, and the bark was rather rough, affording admirable shelters for scale insects. Tree 8 was very badly infested in the spring, and the bark was quite rough. The same was practically true of tree 10. Tree 4 had been attacked by Scolytus rugulosus Ratz., and the sap was exuding copiously.

Aug. 9, there were very few or no living young scale insects on trees 6, 7, 29, 30, 48, 55, 56, 96 and 97, few on trees 4, 4a, 7a and 9, trees 8, 49, 51, 52, 53 and 92, abundant on tree 95, and very abundant on tree 50. Tree 5 had been removed, it probably dying as a result of being partly uprooted.

Sep. 25, there were few or no living scales on trees 6, 55, 56, 96 and 97, few on trees 10, 29, 30, 48, 54, 55 and 75, rather few on trees 4a, 49 and 51; they were rather abundant on trees 4, 7, 7a, 9, 11, 52 and 95, and very abundant on trees 8 and 50. Tree 75 was broken down to the trunk by a heavy crop of fruit, but the semiprostrate limbs showed no evidence of having been attacked by Scolytus rugulosus Ratz. There was a large amount of dead wood on tree 92, and many vigorous shoots. Scolytus was working in the dead wood and also attacking the living to some extent.

The record is about on a par with that of the stronger solution of whale oil soap. The scale has been held in check in most instances, but there is no approach to exterminative work, such as is effected by the mechanical emulsions of crude petroleum. There are comparatively few extenuating circumstances, since only five trees in this large lot were abundantly infested with the scale in the fall of 1900, and, as this condition was due to recent development, the bark of these trees was hardly rough enough to insure much protection to the scales.

Good's whale oil soap no. 3, 2 pounds to the gallon. This solution was tried on 15 trees. They are as follows. Trees 12–14, 57–59 and 98–100 are seckel pear; trees 31–33 and 76–78 are globe peach. Their condition about the close of the growing season, Sep. 7, 1900, was as follows. There were very few or no young scale insects on trees 57 and 78, very few on trees 76, 77 and 98, few on trees 31, 99 and 100; they were rather abundant on trees 58 and 59, abundant on trees 32 and 33, and extremely abundant on trees 12–14.

May 22, tree 100 had set considerable fruit; trees 31, 32 and 77 were injured somewhat by winterkilling, the tips of many of the smaller limbs being dead; tree 76 was also badly affected in this manner.

July 6, there were very few or no young scale insects on trees 31, 32, 57, 76, 77, 78, 98 and 100, few on trees 33, 59 and 99, and rather few on tree 58; they were rather abundant on tree 14, abundant on tree 12, and very abundant on tree 13. The bark of both trees 58 and 59 is quite rough.

Aug. 9, there are very few or no young on trees 31, 32, 33, 57, 76, 77, 78, 98 and 100, and few on tree 59; they were rather abundant on trees 13, 14, 58 and 99, and abundant on tree 12.

Sep. 25, there were few or no living scale insects on trees 57, 98 and 100, few on trees 76 and 78; they were rather abundant on trees 31, 32, 33, 58, 59 and 99, abundant on trees 13, 14 and 77, and very abundant on tree 12.

The record given above is not very bright, particularly when we remember that in this lot there were no very badly infested

trees till the autumn of 1900, when trees 12, 13 and 14 were very badly infested; and, on account of this close proximity to trees in a similar condition on which the scale bred unchecked during the entire season of 1900, it is very probable that they became reinfested during the growing season, and therefore their condition Sep. 25, 1901, should not be taken into account when judging of the merits of whale oil soap; and the same would be true, but to a less extent, of trees 31–33. Even after throwing these trees out of consideration, the results are not equal to those obtained with mechanical petroleum emulsions, though the pest was well controlled.

Summary of experiments

A study of the above records will show that the best results have been obtained with either a 20% or a 25% mechanical emulsion of crude petroleum. Apparently somewhat better results were obtained by the use of the oil purchased from the Standard oil co., but this may be partly accidental. It is a trifle early to be positive regarding this point. It is certain, however, that either the Standard oil or the crude petroleum obtained from the Frank oil co., Titusville Pa., will give very satisfactory results. The whale oil soap and crude petroleum combinations were very effective, but were not so valuable as insecticides as mechanical petroleum emulsions. None of these preparations injured the trees in the slightest degree.

The experiments with the whale oil soap solutions show that, while this substance is valuable as a check, it can hardly be relied on when applied in early spring to do anywhere near so thorough work as the crude petroleum emulsions. The reason for the greater efficiency of the crude petroleum is probably found in the greater penetrative action of the oil. The few tests with the undiluted crude petroleum confirm the experience of the previous year and lead us to conclude that it is a very unsafe substance to apply to trees.

VOLUNTARY ENTOMOLOGIC SERVICE OF NEW YORK STATE

The work of the last two years has been continued, and a large number of observations have been added to previous records. 39 voluntary observers were appointed during the season, and 35 of them have rendered more or less detailed reports. The summaries of these reports, representing as they do, the entomologic conditions in 33 counties, are given below.

Very naturally, owing to the great destructiveness of the forest tent-caterpillar, Clisiocampa disstria, and its close ally, the appletree tent-caterpillar, Clisiocampa americana, many of the reports dwell much on these two insects. The Hessian fly, Cecidomyia destructor, has also received considerable attention at the hands of the voluntary observers.

Summaries of reports from voluntary observers

The scientific names or other matter inserted in brackets indicate determinations or information supplied by the entomologist. The other names are presumably correct, except where questioned. The dates given after the records are those of the reception of the reports, and they are usually from one to three days later than the writing of the report.

Albany county (E. T. Schoonmaker, Cedar Hill)—Forest tent-caterpillars [Clisiocampa disstria] are hatching out in large numbers, and the prospects are that they will be more numerous than last year. Ap. 30. They are eating in the center of the leaf buds and thus making their control exceptionally difficult, though the cold weather of the past week has caused them to remain comparatively inactive up to this date. May 5. Elm leaf beetles [Galerucella luteola] have appeared in limited numbers, though many still remain in buildings. The forest tent-caterpillars are quite abundant on maples, and their ravages are now quite noticeable. Heavy rains have checked their ravages to some extent, but conditions are not favorable for their wholesale destruction. May 21. Striped cucumber beetles [Diabrotica vittata], squash bugs

[Anasa tristis] and crickets are rather few. Young grasshoppers are numerous and are appearing on potatoes and other garden crops. Potato beetles [Doryphora 10-lineata] are very numerous and destructive. Elm leaf beetle grubs are more numerous than last year and are growing very rapidly. Tent-caterpillars have spun their cocoons. The recent rains have caused the disappearance of plant lice on rosebushes and trees. July 9. Elm leaf beetles are now in the pupa stage, and their ravages are equal to those of last year. Striped blister beetles [Epicauta vittata] are exceptionally numerous defoliating many potato patches. A thorough spraying with a strong solution of arsenate of lead has proved very satisfactory. Grasshoppers are more abundant than last year, and quail are devouring them in large quantities. Squash bugs are very numerous and destructive, and many melon patches have been ruined by their ravages. Cabbage butterflies [Pieris rapae] have appeared in small numbers. Spotted grapevine beetles are numerous, and they are doing much damage to grape leaves. Codling moth injury is as great as in former years. July 30.

Chemung county (M. H. Beckwith, Elmira)—[Lecanium cerasifex] is quite abundant on an appletree in my orchard. Mar. 26. Appletree tent-caterpillars [Clisiocampa americana] appeared for the first time Ap. 29. They are much more abundant than last season. May 13. Currant worms [Pteronus ribesii] appeared on gooseberries on May 31, and the first potato beetle [Doryphora 10-lineata] was seen May 21. May beetles [Lachnosterna] are very abundant. May 23. Injury by Hessian fly [Cecidomyia destructor] is very evident in several fields of wheat which I examined today. Probably 10% of the stalks have fallen down on account of the work of the fly. June 29.

Dutchess county (W. F. Taber, Poughkeepsie)—Appletree tent-caterpillars [Clisiocampa americana] are very abundant in many orchards and will probably do much damage if they are not looked after. Heavy rains and cool weather have kept insects in check. May 21.

(H. D. Lewis, Annandale)—The egg masses of both the forest and appletree tent-caterpillars [Clisiocampa americana, C. disstria] are very numerous, and the indications are that these pests will be very destructive. Appletree bark lice [Mytilaspis pomorum] and scurfy bark lice [Chionaspis furfura] are very abundant in this section. Ap. 13. Tent-caterpillars appeared in large quantities from Ap. 25 to May 1, and the forest tent-caterpillars were very numerous about a week later. Both species will be fully as abundant as last year, though the cool wet weather has held them somewhat in check. May 18. Forest tent-caterpillars are more abundant than ever before. Some orchard and shade trees are being completely defoliated by them. The common appletree tent-caterpillar, though numerous. does not appear to be so abundant as last year. The rains have been so frequent that it has been very difficult to keep insecticides on the trees, and consequently these pests are not controlled even by the most careful growers. May 24. There are large numbers of tent-caterpillars of both species. Cutworms are very numerous, and there are some plant lice of different species. The continuous rains have made it very difficult to keep the immense numbers of forest tent-caterpillars under control. June 1. Potato beetles [Doryphora 10-lineata] are just appearing in considerable numbers. Tent-caterpillars are beginning to spin their cocoons, after having caused more injury than ever before. I have noticed robins picking open the cocoons and devouring their contents. Striped squash beetles [Diabrotica vittata] are quite abundant. Injury by the plum curculio [Conotrachelus nenuphar] is apparently much less than for many years. June 17. Fall webworms [Hyphantria cunea] are just making their appearance. Potato beetles are more abundant than they have been for years. June 29. Trees that were defoliated by tent-caterpillars have developed new foliage. Many of the cocoons of the forest tent-caterpillar appear dead and shriveled, but no moths have been seen in this vicinity. July 19. Red-humped appletree worms

[Schizura concinna] are present in small numbers and confined to two or three orchards. The eggs of the appletree tent-caterpillar occur in large numbers, but I fail to find any of the forest tent-caterpillar. Aug. 12. A small webworm, Cacoecia species, is doing a great deal of damage to maples. Aug. 20.

Erie county (M. F. Adams, Buffalo)—Mourning cloak butterflies [Euvanessa antiopa] were flying Ap. 11, and red admirals [Vanessa atalanta] were flying the 13th. The egg masses of the white marked tussock moth [Notolophus leucostigma] are abundant in many localities, and their ravages will probably equal those of 1895. May 10. The young grubs of the willow snout beetle [Cryptorhynchus lapathi] were found abundant in Carolina poplars just beneath the bark. The mines are irregular, winding and extend upward. Goes pulchra is destroying young hickory. May 21. May 19, Saperda fayi had pupated. May 20 the males of the Putnam scale [Aspidiotus ancylus] were emerging. The euonymus scale [Chionaspis euonymi] is quite injurious in this section. May 25. Carpenter worms [Prionoxystus robiniae] were found in the larva and pupa stages in the ash, and to all appearances those which were to emerge this year had already pupated. May 29. June 5 I took adults of Podosesia syringae ovipositing in Fraxinus excelsior and on the same date adults of Neoclytus erythrocephalus were emerging from a dead tree of the same species. The appearances indicate that there will be an unusually large number of the locust borers this season. June 7. Observation in the near vicinity of Buffalo shows that from 6% to 8% of the wheat has been destroyed by Hessian fly [Cecidomyia destructor]. June 11. Graphisurus fasciatus, Xyloterus colonus and Typocerus zebratus have been emerging from Quercus rubra, the first on the 18th and the latter two June 14. Saperda fayi also emerged on the latter date from various species of Crataegus. The willow snout beetle was ovipositing on cotton

woods June 16. Moths of the carpenter worm emerged from ash and poplar June 14. June 19. The cool weather of the spring has apparently kept the white marked tussock moth in check, as the caterpillars are now not over ¼ of an inch in length, while last year on this date many of them were full grown and had commenced to spin their cocoons. June 28. July 4 white marked tussock moth caterpillars were spinning their cocoons in the down town districts. A few have been destroyed by a bacterial disease. July 5. June 28 the last locust borer moth emerged from the the wood. July 17 the female white marked tussock moths were depositing their eggs, and on the same date I obtained examples of the willow snout beetle from the balm of Gilead in the adult larval and pupal stages. The 15 spotted ladybug [Hippodamia 15-punctata] has been exceptionally abundant this season and has proved itself a valuable ally in destroying plant lice. The white marked tussock moth has been quite injurious in many localities in the city, and in some places it was as destructive as in 1895 or in 1898. Parasites appear to be rather scarce. The willow snout beetle is still causing a great deal of injury to poplars and willows in this vicinity. I have taken it from the following varieties: balsam poplar, balm of Gilead, Carolina poplar, Lombardy poplar, Babylonian willow, heart-leafed willow, Kilmarnock willow and from the trunk of the new American weeping willow. I have never taken it from the golden-barked willow, laurel-leaved willow, the silver poplar, the bollean poplar, though a great many of these varieties are growing in the vicinity of the infested trees. July 26.

(J. U. Metz, East Amherst)—The common asparagus beetle [Crioceris asparagi] has appeared for the first time this year. May 20. Hessian fly [Cecidomyia destructor] is present in great abundance, and many fields of white wheat are not worth cutting. I have counted as many as 20 "flaxseeds" in a single stalk. There is apparently no difference between early or late sown wheat. Red Russian and red Mediterranean seem to be exempt thus far from attack. A few

appletree tent-caterpillars [Clisiocampa americana] are seen on wild cherry. July 2. The work of the Hessian fly is becoming more apparent as harvest time approaches, and nearly every stem of wheat is infested. I have an idea that the wheat will yield better than some people surmise at present. I have just been examining my asparagus and have been unable to find any beetles or slugs. Plum curculios [Conotrachelus nenuphar] seem to be worse than usual this year. White grubs or something of that nature must be working in my sheep pasture, as much of the grass is pulled up by the sheep. It seems to be cut off below the surface of the ground by some insect. July 16. Grasshoppers are now very numerous, and my crop of celery for home use has been destroyed by them. July 20.

Fulton county (Cyrus Crosby, Cranberry Creek)—Appletree tent-caterpillars [Clisiocampa americana] do not appear to be very abundant, as I have seen but one nest on an appletree so far this year. Appletrees in this vicinity are nearly all badly infested with the appletree bark louse [Mytilaspis pomorum]. May 8. The cold damp weather has checked the development of insects very much. The nests of the appletree tent-caterpillars are beginning to show up, but they are by no means as thick as they were in Yates county last year. May 17. I find little beetles [Typophorus canellus, a strawberry root worm] on elms. They were very common two weeks ago. June 6. There are a few appletree tent-caterpillars near Mayfield, but elsewhere I have seen none. Only one forest tent-caterpillar [Clisiocampa disstria] was found. Horn flies [Haematobia serrata] are very troublesome to cattle. June 22.

Genesee county (J. F. Rose, South Byron)—Appletree tent-caterpillars' eggs [Clisiocampa americana] began hatching about Ap. 25, and they are now very numerous. One cold day I climbed into a tree for the purpose of crushing the caterpillars in a nest. It was an ideal day for them to be at home, but I found they were scattered for a distance of 2 feet

or more from the nests and were destroying the leaves at a rapid rate. May 10. Colorado potato beetles [Doryphora 10-lineata] are now seen in numbers in gardens, and, as potatoes are not up, the beetles are working on transplanted tomatoes. Early sown turnips and cabbages suffer severely from the cabbage maggot [Phorbia brassicae]. Canker worms are doing great damage in orchards where they were numerous last season. The roadside shrubbery is about defoliated by appletree tent-caterpillars. The sugar maple borer [Plagionotus speciosus] is doing considerable damage in this vicinity. Its work in various trees shows first in dead limbs 40 to 60 feet from the ground, and this renders its control practically impossible. The red wheat, where that has been sown, has suffered very little injury, perhaps 5% to 20%. June 11. A large crop of what early promised to be good wheat will not be worth cutting on account of the Hessian fly [Cecidomyia destructor] injury. Some farmers are plowing up their injured wheat fields and sowing them with other crops, though many will not, as they are anxious to save the seed. Many full grown tent-caterpillars were crawling about the streets June 1 looking for places to spin up. Potato beetles, asparagus beetles [Crioceris asparagi] and striped cucumber beetles [Diabrotica vittata] are present in usual numbers. Currant worms [Pteronus ribesii] are scarce. June 6. I am unable to learn of any white wheat that is not badly injured by the Hessian fly. The red wheat has not been injured to any extent as yet. June beetles have been exceptionally scarce, and cutworms are more than usually abundant. The cabbage maggot has never been so injurious. It took one fourth to one third of 200 early cabbages. Colorado potato beetles are exceptionally abundant on early potatoes. On vines 6 to 8 inches high, which were sprayed with bordeaux mixture and arsenoid, the beetles were pretty thick, and examination showed that they had been cutting off the leaves and eating into the stems of the plants. Both sweet and sour cherries have been nearly ruined by the

cherry aphis [M y z u s c e r a s i] and the new growth of plums and prunes is a solid mass of grayish green plant lice. Reports are coming in that some insect [? P h o r b i a f u s c i c e p s] is seriously injuring beans. June 25. Very little, if any, white wheat will be harvested in this section. 90% of all that is grown in this section is a white wheat known as no. 6. It has been exclusively grown for some years and is a fine yielder. The prospect early in the season was that there would be 20 to 35 bushels to the acre in all fields, as there was little winter injury. A field of white wheat near here, belonging to G. G. Chick, was not sown till the first week in October and looked well much later in May than that early sown, but today he informs me that there will be no wheat. July 2. An eight acre field of white beans, which had been sown on a field of ruined wheat, was found to be seriously infested with some insect. The beans at the time of the examination were 3 to 4 inches high, and there were long spaces in the rows where no plants could be seen at all, and in many other places there were only bare stems with no signs of leaves. [This injury was subsequently identified as probably the work of a small fly, P h o r b i a f u s c i c e p s]. The Hessian fly has also attacked rye, timothy and barley. A perfectly reliable farmer has told me that he has found as many as 50 of the fly maggots in a stalk of barley. One of our large farmers is now cutting his barley and curing it for hay, it is so badly affected. I saw yesterday in Leroy some wheat which is known as Golden chaff or Clausen's Golden chaff. It is a white wheat which appears to be but little troubled by the fly, no more than the red wheat about here. July 9. The pale striped flea beetle [S y s t e n a t a e n i a t a] is quite abundant in some bean fields. July 15. Fall webworms [H y p h a n t r i a c u n e a] appeared for the first time last week. The common squash bug [A n a s a t r i s t i s] is the worst I have ever known it to be. July 27. Tonight a lot of bean plants that have been eaten off or nearly so, so that they fall over and wilt, were brought to me with the statement that the trouble occurred in a number of fields.

No sign of insect injury was observed in the field. The beans are now about 6 inches in hight, and many of them have buds 3 or 4 inches long. [The trouble was referred to the work of a small fly Phorbia fusciceps]. Aug. 2.

Greene county (O. Q. Flint, Athens)—It is the impression in the western part of the county that the forest tent-caterpillar [Clisiocampa disstria] will be much less abundant than in previous years. Ap. 25. Both the forest tent-caterpillar and the appletree tent-caterpillar [Clisiocampa americana] have hatched, and are much more numerous than heretofore in the eastern part of the county, though not so abundant in the western part as when they first appeared in destructive numbers. The forest tent-caterpillars have been exceptionally injurious in the eastern and east-central parts of the county, defoliating appletrees in particular. The same is true in the western portion of Columbia county. The numbers of this pest are much decreased in the western part of Greene county and in Otsego county. The continuous wet weather appears to have retarded the development of the tent-caterpillars. June 5. The forest tent-caterpillars appear to have done the greatest injury, when present in a locality, in orchards, but they have been comparatively harmless in the forests. June 14.

Herkimer county (George S. Graves, Newport)—The appletree bark louse [Mytilaspis pomorum] was exceedingly abundant on Pennsylvania maples in this vicinity. Feb. 11. The first appletree tent-caterpillars [Clisiocampa americana] were observed Ap. 26 in one place and in another May 4. No forest tent-caterpillars [Clisiocampa disstria] have been observed as yet. May 10. The cigar case-bearer [Coleophora fletcherella] is present on appletrees in large numbers and is doing considerable damage to the buds and maples. The nests of the appletree tent-caterpillar are not as plentiful as last year in this locality. Five appletrees here have been practically ruined by the appletree bark louse. The cold weather appears to have delayed the hatching of tent-caterpillar eggs. May 16. A few clusters of the forest tent-caterpillar have

been observed in this locality, but they are comparatively very rare. Currant worms [P t e r o n u s r i b e s i i] have appeared on currant bushes. The currant aphis [M y z u s r i b i s] is not very abundant. May 21. Tent-caterpillars are comparatively scare thus far. A few forest tent-caterpillars were noticed in Poland 4 miles away. The appletree bark louse has also proved quite injurious to cultivated mountain ash and Crataegus in a yard. One orchard near a forest undergrowth is about equally infested with the appletree and forest tent-caterpillars. The cold seems to have kept the tent-caterpillars in check, but plant lice are very numerous and injurious. May 31. Colorado potato beetles [D o r y p h o r a 10 - l i n e a t a] first appeared in considerable numbers May 26. Tent-caterpillars are relatively very scarce. The prolonged rainy weather seems to have kept some insects in check severely, though currant worms are plentiful and quite injurious. June 6. Cabbage butterflies [P i e r i s r a p a e] were noticed June 13, and on the 18th rose beetles were quite abundant. The onion thrips [T h r i p s t a b a c i] is working on our lettuce. The first grubs of the Colorado potato beetle were seen June 13. Grasshoppers seem to be more plentiful than last year and currant worms are unusually abundant. Not a cocoon of either tent-caterpillar has been observed. June 19. Squash bugs were first observed on the vines June 16. Grasshoppers are very plentiful, but so far no particular injury has been done by them. Potato beetles are unusually numerous. Rose beetles [M a c r o d a c t y l u s s u b s p i n o s u s] are attacking the appletrees and rapidly devouring the small apples. June 27. Rose beetles have now disappeared, and it does not seem as if they had caused much injury. Grasshoppers are reported very numerous in the valleys but not on the hills. The spinach flea beetle [D i s o n y c h a c o l l a r i s] has been quite abundant in this vicinity. July 13 two specimens of the praying mantis [M a n t i s r e l i g i o s a] were observed in this place, undoubtedly coming from the eggs sent me last spring, though I have been unable to find any young from their egg clusters. July 13. Caterpillars of the white marked tussock moth [N o t o l o p h u s

l e u c o s t i g m a] were observed Aug. 2.' Grasshoppers do not appear to have caused much damage locally, though they are very abundant. Tortoise beetle grubs [C o p t o c y c l a sp.] are quite plentiful and destructive to morning-glories. The yellow-necked appletree worms [D a t a n a m i n i s t r a] are quite numerous on appletrees. Aug. 12. The common squash bug [A n a s a t r i s t i s] is unusually abundant. The harlequin milkweed caterpillars [C y c n i a e g l e] are quite abundant in this locality. Aug. 20. Fall webworms [H y p h a n t r i a c u n e a] are very plentiful on a great variety of trees. Aug. 27. American sawflies [C i m b e x a m e r i c a n a] were found in considerable numbers on a willow tree. Sep. 18.

Jefferson county (George Staplin jr, Mannsville)—Appletree tent-caterpillars [C l i s i o c a m p a a m e r i c a n a] were hatching Ap. 30. Horn or Texas flies [H a e m a t o b i a s e r r a t a] were observed on cattle May 10. A cluster of forest tent-caterpillars [C l i s i o c a m p a d i s s t r i a] were found on a maple tree May 22, and also a few with appletree tent-caterpillars on appletrees. Potato and May beetles are not plentiful. Appletree tent-caterpillars are not as abundant as they were at the same date last year. Green plant lice are abundant on appletrees. The cold, damp weather has undoubtedly kept many insects in check. May 22. There are very few green worms [X y l i n a species] on appletrees. Appletree tent-caterpillars are not doing very much damage, and the forest tent-caterpillars are very scarce. Plant lice are abundant on plumtrees, causing the leaves on the tips of the branches to curl very badly. The past week has been cold and rainy most of the time. June 13. Yellow-necked [D a t a n a m i n i s t r a] and red-humped [S c h i z u r a c o n c i n n a] appletree caterpillars and fall webworms [H y p h a n t r i a c u n e a] have appeared in small numbers. Grasshoppers are very plentiful in southern Jefferson and northern Oswego counties. Plum curculios [C o n o t r a c h e l u s n e n u p h a r] have done the most damage here. Other insects have not been plentiful enough to cause much injury except the plant lice, and they are very abundant. It has been warm and

dry for the last two or three weeks. Cabbage worms [Pieris rapae] are very abundant. Aug. 2. Fall webworms are very numerous on maples. Many dead grasshoppers are found in the fields. Sep. 3.

Livingston county (W. R. Houston, Geneseo)—Appletree tent-caterpillars [Clisiocampa americana] made their appearance Ap. 28 almost before the buds began to swell. They are just as numerous as last year. I understand that some farmers sprayed before the buds opened. The cold weather seems to keep them in check, and, though they wander over the trees, they do not seem to feed much. May 10. May 17 many nests of the appletree tent-caterpillar were seen in cherry and thorn trees beside the road, and there were also many unhatched eggs. May 24.

Montgomery county (S. H. French, Amsterdam)—The eggs of the European praying mantis [Mantis religiosa] were received in good condition and have been distributed as follows: one packet attached to a small rosebush in my back yard; one in the yard of a friend of mine who lives in the suburbs of the city; and the remainder in the cemetery, where there is plenty of small vegetation. Ap. 17. I have discovered no evidence of the presence in this section of the elm leaf beetle [Galerucella luteola] or of the forest tent-caterpillar [Clisiocampa disstria], and I find very few nests of the appletree tent-caterpillar [Clisiocampa americana]. The latter are not as numerous on cherry or apple trees as usual. May 13.

Niagara county (R. L. Darrison, Lockport)—A large proportion of the winter wheat is seriously damaged by the Hessian fly [Cecidomyia destructor], and where but a few weeks ago there was every promise of an abundant crop, many fields are ruined, and some farmers are now plowing their wheat under. The egg cases of the praying mantis [Mantis religiosa] were distributed among representative farmers, nurserymen and market gardeners, but as yet none have been reported as hatched. June 13. So far only one of the egg cases of the praying mantis has developed satisfactorily. This was placed in a

box with perforations for air and left out of doors except in stormy weather. The insects began to appear on July 2 and between then and the 5th about 100 hatched. All of the egg clusters placed outside or out of doors have apparently failed to develop any insects. July 12.

Oneida county (Jeanette C. Miller, Alder Creek)—Larch saw-flies [Lygaeonematus erichsonii] are quite destructive to some trees in this vicinity. June 19. The argus beetle [Chelymorpha argus] has been very abundant on bindweed in this vicinity, and the sugar maple borer [Plagionotus speciosus] is doing considerable damage to our shade trees. July 25. Caterpillars of the eight-spotted forester [Alypia octomaculata] are abundant on Virginia creeper. July 31.

Onondaga county (Mrs A. M. Armstrong-Jackson, Belle Isle)—House flies [Musca domestica] are appearing, wasps [?Polistes pallipes] are becoming numerous, and the nests of the appletree tent-caterpillar [Clisiocampa americana] are beginning to appear. May 1. Canker worms [?Paleacrita vernata] made their first appearance here May 10, but they are not very abundant. Some appletrees have from seven to 10 webs of the appletree tent-caterpillar on them, and, where no means have been taken to check these pests, they are doing considerable damage. The bud moth larvae occur on apple, quince and plumtrees. Plant lice are present on currant bushes and also on the snowball tree. May16. Forest tent-caterpillars [Clisiocampa disstria] were about half grown May 18, but they are not very destructive. Appletree tent-caterpillars are also doing some mischief in orchards. May 18 a white frost occurred and ice formed on the water in a pan. It apparently did not affect any caterpillars, as none were found dead, though many of them remained in their webs all day. The pistol and cigar case-bearers [Coleophora malivorella and C. fletcherella] are quite abundant on appletrees. Canker worms are not eating much and appear to grow very slowly. May 24. Potato beetles

[Doryphora 10-lineata] are very numerous and destructive. Grubs of the Pennsylvania soldier beetle [Chauliognathus pennsylvanicus] were observed feeding on little green lice. I also think that they feed on the bud moth caterpillars, as a number were found in the foliage recently occupied by them. The Hessian fly [Cecidomyia destructor] is quite abundant in many fields. Two weeks of almost continuous rain have somewhat retarded the development of the insects. June 7. Late sowing does not appear to be a preventive for the Hessian fly in this section. One field sown Sep. 10 was attacked by the fly and stooled freely, but none of the plants died, while in later sown fields much of the wheat was killed by the fall brood of the fly; specially was this true in fields where commercial fertilizers were used, and where the farmer was careless and allowed his fertilizer box to become empty part way across the field. A strip of Mediterranean wheat sown beside the other was very little affected by the fly, while the remainder (Gold coin) is badly infested. Canker worms are doing considerable damage in this vicinity. Two elms near by were defoliated by them. Appletree and forest tent-caterpillars are crawling about, but they are not abundant. Some cherrytrees are badly infested with plant lice, and their leaves are turning brown and drying up. Potato beetles are quite plentiful. June 14. The plum curculio [Conotrachelus nenuphar] has "stung" much fruit, and considerable of it is dropping, but for all that a full crop remains on the trees. The second brood of currant worms is doing considerable damage. Caterpillars are spinning up and canker worms are going into the ground. Some wheat fields in this vicinity are badly infested by the Hessian fly, while others do not appear to have suffered much. June 22.

Ontario county (J. Jay Barden, Stanley)—Appletree tent-caterpillars [Clisiocampa americana] appeared Ap. 25; forest tent-caterpillars [Clisiocampa disstria] Ap. 27; canker worms [?Paleacrita vernata] May 6; and the common asparagus beetle [Crioceris asparagi] May 7.

Appletree tent-caterpillars are not abundant where they were persistently fought last year. Forest tent-caterpillars and canker worms are very abundant in orchards in the vicinity of Rushville N. Y. Pistol case-bearers [Coleophora malivorella] and bud moths [Tmetocera ocellana] are very abundant in this section. The cold weather through April has retarded the appearance of many species. The currant stem girdler [?Janus integer] has been more abundant than ever before, and it is doing much damage. The work of the larvae is showing very plainly at present on account of the lack of foliage on the infested stems. May 10.

Orange county (J. M. Dolph, Port Jervis)—Willow and cabbage butterflies [Euvanessa antiopa and Pieris rapae] were observed May 1, and on the 6th June beetles were seen for the first time. Many maples in this vicinity show effects of the work of the sugar maple borer [Plagionotus speciosus]. May 9. Currant worms [Pteronus ribesii] were first observed May 14, and nests of the appletree tent-caterpillar [Clisiocampa americana] May 15. The appletree bark louse [Mytilaspis pomorum] is apparently less abundant than it was last year. Reports of the prevalence of appletree tent-caterpillars in orchards have come in from various places in this section, though they do not appear to be unusually abundant in this immediate neighborhood. Cutworms are very abundant in gardens. May 27. Fall webworms [Hyphantria cunea] have appeared in great numbers in and about Port Jervis. They seem to have developed suddenly, and they attack a great variety of trees. Aug. 30.

Orleans county (Virgil Bogue, Albion)—Caterpillars of the giant swallowtail [Heraclides cresphontes] were found on my orange tree. Plant lice are somewhat abundant on plum and cherry trees in this section. My crop of cherries was nearly all wormy, probably the work of the cherry fruit fly [Rhagoletis cingulata]. The wheat in this vicinity is in bad condition from attacks by the Hessian fly [Cecidomyia destructor]. Potato beetles [Doryphora 10-

lineata] are very thick and doing considerable damage. July 17.

Oswego county (C. D. Cook, Oswego Center)—Appletree tent-caterpillars [Clisiocampa americana], bud moths [Tmetocera ocellana] and cigar case-bearers [Coleophora fletcherella] appeared about the time the buds began to develop, the two former being abundant, the tent-caterpillars being exceedingly so. No forest tent-caterpillars [Clisiocampa disstria] have been observed thus far. Plant lice [Aphis mali] are abundant on appletrees, and many cigar case-bearers can be found. May 20. Currant worms [Pteronus ribesii] and cutworms are numerous and causing considerable injury. Plant lice are very abundant on plum, pear and apple trees. Tent-caterpillars have not caused much injury to the trees. The cold, wet weather has retarded the development of insect life. June 5. Hessian fly [Cecidomyia destructor] has caused considerable damage in this vicinity. June 19. The forest tent-caterpillar has been very destructive in Yates county, the woods about Penn Yan being brown and bare in places from their work. The appletree tent-caterpillar has also been quite injurious about Penn Yan. July 8.

Otsego county (L. I. Holdredge, Oneonta)—Willow and cabbage butterflies [Euvanessa antiopa and Pieris rapae] have made an early appearance this season, and the currant plant louse [Myzus ribis] is present in great numbers. May 6.

Queens county (C. L. Allen, Floral Park)—Cabbage butterflies [Pieris rapae] appeared in large numbers about May 10. The rains have destroyed nearly all of them, however. Potato beetles [Doryphora 10-lineata] are less numerous than usual. June 21. The destructive pea aphis [Nectarophora pisi] appeared about June 18, and thus far it has done but little damage. At the present time there are few or none to be seen, the severe rains having apparently destroyed them. July 9. Fall webworms [Hyphantria cunea] appeared in im-

mense numbers about the middle of August, and their webs were very conspicuous on a great many trees. They are doing immense damage in this vicinity. Aug. 29.

Rensselaer county (W. C. Hitchcock, Pittstown)—Appletree tent-caterpillars [Clisiocampa americana] are present in immense numbers. May 20. The cold, wet weather appears to have kept both the appletree and forest tent-caterpillars [Clisiocampa disstria] in check, as they seem to have been very scarce. The elm leaf beetle [Galerucella luteola] is not proving very destructive this season. July 2. Round-headed appletree borers [Saperda candida] are quite injurious in this section. The trees receive little attention, and are therefore soon ruined by the borers. Grasshoppers are unusually scarce. July 15.

Rockland county (S. B. Huested, Blauvelt)—Appletree tent-caterpillars [Clisiocampa americana] first appeared May 4. The season has been cold and backward. May 8. We have not seen the June beetle as commonly as last year. Last month potato beetles [Doryphora 10-lineata] were very troublesome. Aug. 5.

St Lawrence county (Mary B. Sherman, Ogdensburg)—Shad or May flies appeared as usual June 5 and were very abundant for three days. Forest tent-caterpillars [Clisiocampa disstria] are scarce, only four or five having been seen during the summer. Currant worms [Pteronus ribesii] appeared about a week ago. There are many complaints of injury by wireworms. June 22. Caterpillars of the white marked tussock moth [Notolophus leucostigma] are abundant. July 8. Complaints of injury by currant worms are less frequent than usual. Plant lice are unusually abundant and destructive. July 12. Cabbage butterflies [Pieris rapae] are now quite abundant. A large number of cut-leafed birches have been seriously damaged, without apparent cause. [This is possibly the work of the bronze birch borer, Agrilus anxius.] All plant lice are unusually abundant. Many complaints are made regarding the abundance of fleas

on cats and dogs. Potato beetles [Doryphora 10-lineata] and cabbage worms are very abundant. Aug. 2. The birch leaf Bucculatrix [Bucculatrix canadensisella] is exceedingly abundant in this vicinity, having skeletonized the majority of the leaves on almost all the birches in this region. Sep. 12.

Saratoga county (Miss Rhoda Thompson, Ballston Spa)—There are fewer appletree tent-caterpillars [Clisiocampa americana] and more plant lice and cutworms than there have been for the last two years. Currant worms [Pteronus ribesii] have also been very abundant. June 7. Rose beetles [Macrodactylus subspinosus] and wireworms are about as abundant as usual. Squash bugs [Anasa tristis] are present in enormous numbers and are causing considerable injury. July 12. There is a plague of grasshoppers in this vicinity, and they are doing a great deal of mischief. It was found they had cut off from two thirds to three fourths of the grain in a field of oats. Corn has also been much injured. Some farmers are cutting their grain before maturity in order to save it from injury.

Schenectady county (Paul Roach, Quaker Street)—Forest tent-caterpillars [Clisiocampa disstria] were first observed on the south side of the woods. May 5. Appletree tent-caterpillars [Clisiocampa americana] and forest tent-caterpillars will probably be fewer than last year. The cold, wet weather appears to have retarded the hatching of eggs and development of insect life. Bud moth larvae [Tmetocera ocellana] are present in small numbers. May 8. There are only a few appletree tent-caterpillars on the wild cherrytrees. The season has been cold and excessively wet, and not many of the caterpillar eggs appear to have hatched. May 31.

Schoharie county (John F. Johnson, Breakabeen)—Appletree tent-caterpillars [Clisiocampa americana] were first observed May 1, and forest tent-caterpillars [Clisiocampa disstria] May 7. The former are abundant, and the latter not more than half as numerous as last year. The cold, rainy

weather seems to have kept insect pests in check. May 13. Forest tent-caterpillars have not done much damage. They are about one third as abundant as last year. Plant lice are quite numerous on apple, plum and cherry trees. Currant worms [Pteronus ribesii] are quite abundant in this vicinity. June 6. Potato beetles [Doryphora 10-lineata] have appeared, and plant lice are quite abundant on cherrytrees, causing the leaves to shrivel and die. Forest tent-caterpillars are spinning their cocoons and have not caused much damage. Grasshoppers are present in large numbers. The moths of the forest tent-caterpillar appeared July 1 and have commenced to deposit eggs. Potato beetles are very abundant. July 11. Grasshoppers are very numerous and are injuring corn and buckwheat. Aug. 12.

Schuyler county (Harriet M. Smith, North Hector)—Appletree tent-caterpillars [Clisiocampa americana] were first seen May 1, canker worms [?Paleacrita vernata] May 6. The latter have been very destructive to buds and small leaves on plumtrees. The tent-caterpillars are very abundant, but have caused but little damage as yet. May 17. Both the common and the 12 spotted asparagus beetles [Crioceris asparagi and C. 12-punctata] are abundant. Canker worms are defoliating many maple trees. Owing to the destruction of the nests of the appletree tent-caterpillar in orchards, this pest has caused but little injury in this vicinity. The late storm has apparently killed many insects. June 7. White marked tussock moth caterpillars [Notolophus leucostigma] have been quite injurious to horse chestnut trees. Oats are reported as seriously damaged by a plant louse in Seneca county. July 12. I am unable to learn of any wheat being seriously injured by the Hessian fly [Cecidomyia destructor] in this vicinity, as most of it was sown late. June 14. Potato beetles [Doryphora 10-lineata] appeared for the first time this season about June 15, and they are now present in great abundance. June 21. The Hessian fly has injured wheat at North Reading. July 19.

Seneca county (J. F. Hunt, Kendaia)—Appletree tent-caterpillar [Clisiocampa americana] eggs hatched Ap. 26, and those of the forest tent-caterpillar [Clisiocampa disstria] May 3. Canker worms [? Paleacrita vernata] commenced work on appletrees about May 1. May 7. Cherry aphids [Myzus cerasi] have just begun to appear. Both appletree and forest tent-caterpillars are less abundant than last year. There are not so many nests of the former species to be seen. The steely blue grapevine beetle [Haltica chalybea] has not been seen this spring in localities where it was abundant last year. May 17. Currant worms [Pteronus ribesii] appeared May 20, and work of the plum curculio [Conotrachelus nenuphar] is now evident, but this pest is not so injurious as in former years. The forest tent-caterpillar in particular is not so abundant as it has been in recent years. Bud moths [Tmetocera ocellana] are more numerous than for years. Currant worms and raspberry sawflies [Monophadnoides rubi] are both scarce. The fruit tree bark beetle [Scolytus rugulosus] is working quite abundantly in plum and peachtrees, but not so badly, however, in the latter. The orchard which the canker worms defoliated last year and in which they appeared this year is now all right, the pests having been controlled by two sprayings. May 29. The work of the Hessian fly [Cecidomyia destructor] is now in evidence, it having destroyed about one third of some species of wheat, and there are but few curculio marks on apricots and plums. Tent-caterpillars are showing up a little more abundantly than was reported last week. There are no potato beetles [Doryphora 10-lineata] to speak of yet. The last week of rain has apparently had no bad effect on the caterpillars. June 7. Eggs of the potato beetle are beginning to hatch, and the parent insects are very plentiful. Tent-caterpillars are now leaving the trees and spinning cocoons. The Hessian fly is very destructive in some pieces of wheat, while in others not much is seen of it. Zebra caterpillars [Mam-

estra picta] were found in small numbers on a red raspberry bush. June 21. Squash bugs [Anasa tristis] are very numerous and in some gardens have destroyed all the vines. The small black flea beetle [Epitrix cucumeris] is very abundant in some bean fields. The work of what is evidently a Thrips is very plain in many timothy fields. The Hessian fly is not causing so much damage in this vicinity as was at first feared. July 10. The cherry fruit fly [Rhagoletis cingulata] has caused some injury in this vicinity, and I have been able to catch the flies on the fruit. I have gone over my cherry orchard twice and a part of it three times and have gathered from it the affected fruit, which was then put into vessels containing water, and the maggots drowned. I picked 25 pounds of infested cherries from four trees, and bushels of wormy ones, in my orchard. Cucumber flea beetles are quite injurious to potato vines. The Hessian fly has completely destroyed all the barley and spring wheat in this section. Winter wheat in the center of the county is good, while at each end it is badly damaged by the fly. July 24.

Tompkins county (C. E. Chapman, Peruville)—Appletree tent-caterpillars [Clisiocampa americana] appeared May 1, and on the 9th they were very abundant. May 14. Hessian fly larvae [Cecidomyia destructor] are in nearly every wheat stalk, from one to four in each. Many fields are nearly ruined, and the yield will not be more than one half the usual crop. The wheat also appears to be damaged by an insect which eats the straw nearly in two about an inch from the surface of the ground. It is probably the work of the sawfly [?Cephus pygmaeus]. Forest and appletree tent-caterpillars are on all the trees in this section but not in sufficient numbers to cause much damage. June 25. Chinch bugs [Blissus leucopterus] occur here and there in small spots on different farms. One piece of millet was badly injured. They have also attacked grass among blackberry bushes. Grasshoppers are very thick, but wet weather appears to keep them in check. Squash and other vines have been nearly de-

stroyed by the common stink or squash bug [Anasa tristis]. The apples are much infested with codling moth larvae [Carpocapsa pomonella]. Potato beetles are very abundant. Aug. 20.

Ulster county (George S. Clark, Milton)—Currant worms [Pteronus ribesii] were first observed May 7, and only a few are to be found at the present date. Appletree tent-caterpillars [Clisiocampa americana] were first seen about May 1, and in sections where they were kept under control last year, there are only a few, but in other places they are doing considerable damage. May 16. Cherry aphis [Myzus cerasi] is rather abundant on cherrytrees. May beetles are present in some numbers and are cutting the leaves of trees badly. May 31. Plant lice appear to be increasing slowly. Appletree tent-caterpillars are now wandering considerably. June 7. Cucumber flea beetles [Epitrix cucumeris] are at work on tomato and potato vines, injuring them considerably. Some trees in this section have been entirely defoliated by tent-caterpillars, but this is exceptional. June 14. Cherry plant lice are quite injurious to young trees. June 21. There are very few currant worms in the second brood. The potato beetles [Doryphora 10-lineata] are easily controlled. June 28. The lightning leaf-hopper [Ormenis pruinosa] is quite abundant in a pear and currant plantation, being so numerous as to partly cover many of the twigs with their cottony secretion. It is not an injurious species as a rule. July 11.

Warren county (C. L. Williams, Glens Falls)—Forest tent-caterpillars [Clisiocampa disstria] are generally distributed in this section, but they have not been numerous enough to cause much of any damage. The caterpillars of the white marked tussock moth [Notolophus leucostigma] are present in small numbers. July 5.

Wayne county (C. H. Stuart, Newark)—I am sending you a worm found in quince seedlings which proved to be the larva of the leopard moth [Zeuzera pyrina]. June 30. The Hessian fly [Cecidomyia destructor] is even worse

here this year than last, when it attacked nearly three fourths of the crop. Our season has been extremely wet, and I think that both of the tent-caterpillars and aphids have been later than usual, but now they are very abundant. June 5. Canker worms [? Paleacrita vernata] are even worse than last year, and very little effort is being made to check them. They have attacked forest trees badly in some sections, seeming to favor the elms and spreading from them to neighboring orchards. The appletree and forest tent-caterpillars [Clisiocampa americana and C. disstria] are very abundant on apple and cherry trees, but during a long drive yesterday, I saw nests only in apple and cherry trees. This is a great contrast to last year, when they worked on nearly everything. They are now crawling along the fences, sidewalks and roads, looking for places in which to spin up. Our fields (we have some 60 acres scattered around in different places) look uniformly bad from attack by the Hessian fly. They were sowed beginning Sep. 20 and ending a week later. Our wheat is as near a complete failure as it is possible to be and yield anything. We may get 5 or 6 bushels to the acre, but we shall probably plow the greater part of it. Both asparagus beetles are present here, but the 12 spotted one [Crioceris 12-punctata] is rare. The common form [Crioceris asparagi] is so bad that it is almost impossible to find any asparagus on the market except that which is covered with its eggs. June 11. I am mailing a number of apricot twigs infested with what is apparently a peach twig moth. [Cenopis diluticostana Walsm., kindly determined by Prof. C. H. Fernald, subsequently was bred from these twigs.] The pale striped flea beetle [Systena taeniata] observed by us working on seedling appletrees last year, is now attacking sugar beets. June 24. The small beetles [Notoxus anchora] sent herewith are very numerous around the roots of wheat. In our seed bed we have several varieties of wheat, all of which were badly injured by the Hessian fly except a check row of "Dawson's golden chaff," not a single straw of which is down. This check row was sown

by hand, the rest by machine, and was put in about 1 inch deeper than the rest. All the varieties were sown at about the same time. June 28.

Westchester county (Mrs. Edwin H. Mairs, Irvington-on-Hudson)—Appletree tent-caterpillars [Clisiocampa americana] were observed in immense numbers. May 7. We have had few warm days and a great deal of cold wet weather, which has kept insect life pretty well in check. May 14. The grapevine plume moth caterpillars [Oxyptilus periscelidactylus] are doing some injury to grapevines. The beech aphis [Phyllaphis fagi] is present on purple beeches. Appletree tent-caterpillars are still very abundant. May 29. They are now leaving the trees and crawling in every direction in search of places in which to spin up. In one orchard I saw enough of them to stock the earth. June 6. Green June beetles [Allorhina nitida] were first observed July 7. They eat out the buds of the common flowers and are destroying the plants. This is the insect which has been reported in the newspapers as the wonderful "flying, boring bug." Spotted grapevine beetles [Pelidnota punctata] have appeared in great numbers. The common June beetles are somewhat troublesome. White marked tussock moth caterpillars [Notolophus leucostigma] are present in small numbers. July 20. Fall webworms [Hyphantria cunea] are very abundant in this section, and their nests can be seen on a great variety of trees and shrubs. Sep. 6.

Wyoming county (W. H. Roper, Wyoming)—Appletree tent-caterpillars [Clisiocampa disstria] appeared May 2. They are plentiful, but are not doing much damage as yet, since the weather is cool and damp. May 13. They have not been working for the last three days, because the weather has been cold, but not cold enough to kill them. May 17. The tent-caterpillars are doing a great deal of damage in this locality where the trees have not been sprayed. The canker worm [? Paleacrita vernata] has also made his appearance and is causing a great deal of injury. Had it not been for the

cold, wet weather, the caterpillars would have caused a great deal more damage than they have. May 29. Tent-caterpillars and canker worms are devouring the foliage very rapidly in some orchards. The latter are not doing as much injury in the woods this year as last. June 7. I find no canker worms in my orchard, but there are a great many in this vicinity, and the elm-trees are full of them. Some trees have been entirely defoliated. The Hessian fly [Cecidomyia destructor] has caused a great deal of injury to wheat in this section, and many crops will not be harvested because there is nothing worth cutting. The white wheat has been severely injured, while the red wheat has apparently escaped with little or no harm. June 19. I have four acres of white wheat which was sown Sep. 19. It has not been injured by the fly. It is known as the "Genesee giant." The straw is very coarse and stands up in fine shape. My no. 6, sowed the next day, is about one half gone. The wheat on the hills has been injured much more than that in the valley. July 3.

LIST OF PUBLICATIONS OF THE ENTOMOLOGIST

The following is a list of the principal publications of the entomologist during the year 1901. 62 are given with title,[1] place and time of publication and a summary of the contents of each. Volume and page numbers are separated by a colon, the first superior figure tells the column, and the second the exact place in the column in ninths; e. g. 65: 862^{18} means vol. 65, p. 862, column 1, beginning in the eighth ninth, i. e. about eight ninths of the way down.

Grain moth (Country gentleman, 25 Oct. 1900, 65: 862^{18})

The attack on wheat at Highlands N. J. is identified as that of Sitotroga cerealella Oliv.

Wooly aphis (Country gentleman, 25 Oct. 1900, 65: 862^{44})

Identifies and gives remedies for Schizoneura lanigera Hausm. attack on appletrees at Troy N. Y.

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[1] Titles are given as published; and in some instances they have been changed or supplied by the editors of the various papers.

Whale oil soap experiments (Country gentleman, 1 Nov. 1900, 65: 884[41])

Gives results obtained with Good's whale oil soap.

Celery Plusia (Country gentleman, 1 Nov. 1900, 65: 884–85[46])

Plusia simplex Guen. is identified from Colora Md., its life history is given, and remedies indicated. Ormenis [Poeciloptera] septentrionalis Spin. is mentioned.

Some effects of early spring applications of insecticides on fruit trees (U. S. dep't agric. div. ent. Bul. 26, n. s. 1900. [rec'd Nov. 8] p. 22–25)

Gives effects of kerosene, crude petroleum and whale oil soaps in various dilutions and mixtures.

Hessian fly (Country gentleman, 22 Nov. 1900, 65: 942[25])

Gives rule for ascertaining date of disappearance of [Cecidomyia destructor Say] and recommends preventive measures.

Remedies for San José scale (Country gentleman, 29 Nov. 1900, 65: 965[21])

Summarizes results obtained with kerosene, crude petroleum, whale oil soaps and hydrocyanic acid gas. A 20% mechanical emulsion of crude petroleum proved very satisfactory. Whale oil soap was not so efficient. Hydrocyanic acid gas was the most satisfactory, but its application is limited on account of the costly tents.

Scale on Japan plum (American gardening, 8 Dec. 1900, 21: 811[21])

San José scale, Aspidiotus perniciosus Comst., from Rye N. Y., is identified, and early spring treatment with whale oil soap or crude petroleum advised.

Work of the state entomologist (Albany evening journal, 18 Dec. 1900, p. 4)

Replying to a suggestion, the work of the office is briefly outlined.

Wheat damaged by moth (Country gentleman, 10 Jan. 1901, 66: 24[32])

Gives remedies for Angoumois or grain moth, Sitotroga cerealla Oliv., which is reported abundant in New Jersey.

Serious injury by bark-borers (Riverhead [N. Y.] news, 26 Jan. 1901, p. 1–30 cm)

A brief account of injuries to hard pines at Manor L. I. by Tomicus calligraphus Germ., T. cacographus Lec. and Dendroctonus terebrans Oliv. Several preventive measures are advised.

Wireworms (Country gentleman, 28 Feb. 1901, 66: 168)

The larva of Melanotus communis Gyll. from Orange county, N. Y. is identified, and several preventive and repressive measures advised.

[Insect lessons of the year] (Country gentleman, 28 Feb. 1901, 66: 170[24], 7 Mar. p. 192)

Extracts from report of committee on insects of Eastern N. Y. horticultural society, in which the following are noticed: pale striped flea beetle, Systena taeniata Say, gipsy moth, Porthetria dispar Linn., appletree aphis, Aphis mali Fabr., cherrytree aphis, Myzus cerasi Fabr., destructive pea louse, Nectaro|phora pisi Kalt., white flower cricket, Oecanthus niveus DeG., the minute black ladybeetle, Pentilia misella Lec., fruit tree bark beetle, Scolytus rugulosus Ratz., palmer worm, Ypsolophus pometellus Harr., forest tent-caterpillar, Clisiocampa disstria Hübn. and the leopard moth, Zeuzera pyrina Fabr. The second part is a discussion of results obtained in experiments against San José scale with kerosene, whale oil soap and crude petroleum in various combinations.

Scurfy bark louse (Country gentleman, 28 Mar. 1901, 66: 256–57[46])

Chionaspis furfura Fitch on pear and apple trees is briefly characterized, and remedies given.

Grapevine Aspidiotus (Country gentleman, 4 Ap. 1901, 66: 278–79[47])

Aspidiotus uvae Comst. from Nashville Tenn. is identified, compared briefly with the San José scale, and remedial measures are indicated.

Injurious insects and how to control them. (N. Y. state agric. soc. Rep't 1899. 1900. pt 2. Bureau of farmers institutes. Rep't [issued 15 Ap. 1901] p. 267–93. Also Dep't agric. 7th rep't. 1900. v. 3, pt 2, p. 59–85)

General paper treating of a number of insects, the appletree tent-caterpillar, Clisiocampa americana Fabr., forest tent-caterpillar, Clisiocampa disstria Hübn., codling moth, Carpocapsa pomomella Linn., sugar maple borer, Plagionotus speciosus Say, elm borer, Saperda tridentata Oliv., elm leaf beetle, Galerucella luteola Müll., appletree and scurfy bark lice, Mytilaspis pomorum Bouché and Chionaspis furfura Fitch, and the San José scale, Aspidiotus perniciosus Comst. being specially mentioned.

A large number of the more important insect pests are briefly characterized, and remedies for them are given in the reprinted catalogue of the collection exhibited at certain institutes.

Household insects (N. Y. state agric. soc. Rep't, 1899. 1900. pt 2 Bureau of farmers institutes. Rep't [issued 15 Ap. 1901] p. 294–303. Also Dep't agric. 7th rep't. 1900. v. 3, pt 2, p. 86–95)

A general paper treating of the following: mosquitos, Culex, house fly, Musca domestica Linn., fleas, Ceratopsyllus serraticeps Gerv., carpet beetles, Anthrenus scrophulariae Linn. and Attagenus piceus Oliv. and clothes moths, Tinea pellionella Linn. and others, house ants, Monomorium pharaonis Linn. and others, cockroaches, Phyllodromia germanica Fabr. and Periplaneta orientalis Linn., bedbug, Acanthia lectularia Linn., larder beetle, Dermestes lardarius Linn., cheese or ham skipper, Piophila casei Linn., fruit flies, Drosophila ampelophila Loew, bristle tail or fish moth, Thermobia furnorum Rov.

16th report of the state entomologist on injurious and other insects of the state of New York (N. Y. state mus. Bul. 36. 1901. [issued 25 Ap.] p. 949–1063)

Contents

1 General account of each, giving life history and habits.

2 Brief records of some of the more interesting facts brought to notice in 1900.

Tent-caterpillars (Country gentleman, 9 May 1901, 66: 386[24])

Remedies are given for both species.

Enemies of trees (Troy daily times, 10 May 1901, 37cm)

Brief general accounts of the elm leaf beetle, Galerucella luteola Müll., forest tent-caterpillar, Clisiocampa disstria Hübn., and the elm bark louse, Gossyparia ulmi Geoff.

Entomologic service of New York (Country gentleman, 16 May 1901, 66: 403[22])

Summary of reports from voluntary observers.

Trap-lanterns—Warning (Country gentleman, 16 May 1901, 66: 406[17]; New York farmer, 16 May 1901, p. 3)

Statement to the effect that trap lanterns are of value in only a few very special cases.

Spraying and poultry (Country gentleman, 23 May 1901, 66: 423[23])

Grass under properly sprayed trees will not be injurious to poultry.

Scale on raspberry (Country gentleman, 23 May 1901, 66: 423[33])

Aulacaspis rosae Sandb. from Concordville Pa. is identified, and the proper treatment indicated.

Hessian fly—borers (Country gentleman, 30 May 1901, 66: 442[37])

Preventive methods are given for Cecidomyia destructor Say, the fruit tree bark-borer, Scolytus rugulosus Ratz., and the locust borer, Cyllene robiniae Forst.

Entomologic service of New York (Country gentleman, 30 May 1901, 66: 443[13])

Summary of reports from voluntary observers.

Recent problems in the control of insects depredating on fruit trees (Mass. fruit growers ass'n. 7th rep't. 1901 [rec'd 6 June] p. 27–45)

The following topics are treated: Care of literature, Dissemination of insects, Results obtained in 1900 with insecticides, the latter principally a discussion of kerosene, whale oil soaps and crude petroleum.

Voluntary entomologic service of New York state (Country gentleman, 6 June 1901, 66: 462–63[47])

Summary of reports from voluntary observers.

Voluntary entomologic service of New York state (Country gentleman, 13 June 1901, 66: 482[34])

Summary of reports from voluntary observers.

Hessian fly (Country gentleman, 13 June 1901, 66: 486[42]; New York farmer, 13 June 1901, p. 8; —— 27 June, p. 7; American agriculturist, 22 June 1901, p. 816, col. 1)

Brief statement of injuries by Hessian fly. Cecidomyia destructor Say, and a request for data concerning infested fields.

Hickory gall—San José scale (Country gentleman, 20 June 1901, 66: 502[35])

The life history and characteristics of Phylloxera caryaecaulis Fitch are briefly given, and Aspidiotus perniciosus Comst. is identified. Both are from Bedford Station N. Y.

Voluntary entomologic service of New York state (Country gentleman, 20 June 1901, 66: 503[14])

Summary of reports from voluntary observers.

Voluntary entomologic service of New York state (Country gentleman, 27 June 1901, 66: 523[23])

Summary of reports from voluntary observers.

Lunate long sting (Country gentleman, 4 July 1901, 66: 542–43[46])

A brief notice of Thalessa lunator Fabr. from Loudonville N. Y., with mention of its host, the pigeon tremex, Tremex columba Linn.

Voluntary entomologic service of New York (Country gentleman, 4 July 1901, 66: 543[23])

Summary of reports from voluntary observers.

Fruit tree bark beetle (Country gentleman, 4 July 1901, 66: 554[11])

Brief general account of Scolytus rugulosus Ratz. in New York state.

Squash bug (Country gentleman, 11 July 1901, 66: 562[32])

Anasa tristis DeG. is figured and briefly noticed.

Voluntary entomologic service of New York state (Country gentleman, 11 July 1901, 66: 563[17])

Summary of reports from voluntary observers.

Leaf-cutter bee (Country gentleman, 18 July 1901, 66: 582[33])

Cells of Megachile species from Chase Lake N. Y. are identified and the habits of insect given.

Voluntary entomologic service of New York (Country gentleman, 18 July 1901, 66: 583[13])

Summary of reports from voluntary observers.

Voluntary entomologic service of New York (Country gentleman, 25 July 1901, 66: 603[13])

Summary of reports from voluntary observers.

Plum curculio (Country gentleman, 25 July 1901, 66: 604[26])

Work of beetles of Conotrachelus nenuphar Hbst. on plum leaves is identified, and remedy given. Codling moth larvae in quince and a blight noticed briefly. All were from Setauket L. I.

Voluntary entomologic service of New York (Country gentleman, 1 Aug. 1901, 66: 623[13])

Summary of reports from voluntary observers.

Larch lappet (Country gentleman, 8 Aug. 1901, 66: 642[23])

The larva of Tolype laricis Fitch from Coldwater N. Y. is identified, and its peculiarities sketched.

Voluntary entomologic service of New York state (Country gentleman, 8 Aug. 1901, 66: 442–43[48])

Summary of reports from voluntary observers.

A great insect book (Country gentleman, 8 Aug. 1901, 66: 646–47[15])

A review, with some editorial additions, of the *Insect book* by Dr L. O. Howard.

Rabbit botfly (Poultry monthly [Albany N. Y.] Sep. 1901, p. 497–98)

Identifies maggot from Belgian hare in New York as probably Cuterebra cuniculi Clark and gives its life history briefly and remedies.

Borers in shade trees (American gardening, 10 Aug. 1901, 22: 558)

Poplar borer at New York is possibly Saperda calcarata Say. Injection of carbon bisulfid is recommended, or the use of potassium cyanid.

Blister beetles (Country gentleman, 15 Aug. 1901, 66: 662[17])

Margined blister beetle, Epicauta cinerea Forst., from Lahaska Pa. is identified, and remedies given.

Cicada-killer (Country gentleman, 22 Aug. 1901, 66: 682[34])

Sphecius speciosus Drury from Stillwater N. J. is identified, and its occurrence at Karner N. Y. recorded.

Sugar maples injured (Country gentleman, 19 Sep. 1901, 66: 762[47])

The depredator at Dutchess county, N. Y., is identified as probably Cacoecia argyrospila Walk.

Ichneumon fly (Country gentleman, 26 Sep. 1901, 66: 782[14])

Paniscus geminatus Say from Croton on Hudson N. Y. is described and identified.

Orange dog (Country gentleman, 26 Sep. 1901, 66: 782[15])

The larva of Heraclides cresphontes Cram. from Albany N. Y. is described, and its unusual abundance in New York noted.

Angoumois moth (Country gentleman, 26 Sep. 1901, 66: 782[24])

Sitotroga cerealella Oliv. from Smithtown L. I. is identified, and remedial measures given.

Birch leaf Bucculatrix (Country gentleman, 26 Sep. 1901, 66: 787[29])

A brief account of the prevalence and destructiveness of Bucculatrix canadensisella Chamb. in New York state.

Golden oak scale and leaf feeder (Country gentleman, 26 Sep. 1901, 66: 789[23])

This scale, Asterolecanium variolosum Ratz., is described, remedies given and the leaf feeder identified as possibly Symmerista albifrons Abb. & Sm.

Ants on fig trees (Country gentleman, 26 Sep. 1901, 66: 789[28])

Several means of keeping these insects out of trees are discussed. The ants are said to devour the fruit.

Celery worms (Country gentleman, 26 Sep. 1901, 66: 789[35])

The caterpillar, Papilio polyxenes Fabr., from Islip L. I. is described, and the use of slug shot on celery discountenanced. Hand picking is advised.

Saddle back caterpillar (Country gentleman, 26 Sep. 1901, 66: 789[38])

The larva of Sibine stimulea Clem., from Greenwich Ct., is described, and its food plants given.

Hessian fly in New York state (Country gentleman, 3 Oct. 1901, 66: 799[43]–800[11])

Summary account of injuries by Cecidomyia destructor Say, with remedial measures.

Appletree borer (Country gentleman, 3 Oct. 1901, 66: 803[28])

Remedial and preventive measures for Saperda candida Fabr. are given.

Borers and plant lice (Country gentleman, 10 Oct. 1901, 66: 829[11])

A general account of injuries to firs in the Adirondacks by Tomicus balsameus Lec. with mention of other species. General directions are given for the use of insecticides.

CONTRIBUTIONS TO COLLECTION 16 OCT. 1900–15 OCT. 1901

Hymenoptera

Apis mellifica Linn., honey bee, queen and workers, 5 Oct.; from **Harold Horner**, Mount Holly N. J.

Xylocopa virginica Drury, carpenter bee, pupae in hard pine board, 30 July; from **James F. Feeney**, Albany N. Y.

Megachile sp.; cells, 23 July; from **Harriet M. Smith**, North Hector N. Y.

Vespa maculata Linn., white-faced hornet, nest, 30 Ap.; from Mrs **C. L. Hoffman**, Castleton N. Y. Large nest of same, 19 Ap.; from Samuel Brutkus, New Baltimore N. Y.

Sphecius speciosus Drury, cicada-killer, adult, 12 Aug.; from **S. P.**, Stillwater N. J.

Sphex ichneumonea Linn., 8 Sep.; from Miss **Eliza S. Blunt**, New Russia N. Y.

?Sphaerophthalma occidentalis Linn., velvet ant, 7 Sep.; from Dr **M. W. Van Denburg**, Mount Vernon N. Y.

Dibrachys boucheanus Ratz., adults issuing from braconid cocoons on a sphingid larva, 13 Aug.; from **B. F. Koons**, Storrs Ct.

Thalessa lunator Fabr., lunate long sting, adult, 25 June; from **C. S. Bradt,** Albany N. Y. Same, 25 June; from **L. Tucker & Son,** Albany N. Y. Same, 28 July; from **C. W. Walker,** McGregor Ia. Same, 13 Sep.; from **C. J. Moore,** Albany N. Y.

Thalessa atrata Fabr., black long sting, adult, 29 May; from **O. Q. Flint,** Athens N. Y. Same, 25 June; from **C. S. Bradt,** Albany N. Y. Same, 2 July; from **Fred Calhoun,** Albany N. Y.

Paniscus geminatus Say, adult, 18 Sep.; from **J. H. H.,** Croton on Hudson N. Y.

Tremex columba Linn., pigeon tremex, adult on decayed and dying elm, 24 Aug.; from **Jeanette C. Miller,** Aldercreek N. Y.

? Cephus pygmaeus Linn., wheat sawfly, larvae in wheat stalks, 9 July; from **C. H. Stuart,** Newark N. Y.

Lygaeonematus erichsonii Hartig., larch sawfly, larvae on larch, 19 June; **Jeanette C. Miller,** Aldercreek N. Y.

Cimbex americana Leach, American sawfly, adult, 5 June; from Dr **J. Benton Tipton,** Albany N. Y. Larvae of same on willow, 16 Sep.; from **G. S. Graves,** Newport N. Y. They must have been very abundant, as numerous examples were sent.

Coleoptera

Scolytus rugulosus Ratz., fruit tree bark beetle, larvae and pupae on peach, 16 Mar.; from **J. A. Hepworth,** Marlboro N. Y. Same on plum, 25 June; **A. M. W.,** Troy N. Y.

Madarus undulatus Say., adult from fruit of thorn bush, 10 Oct.; from **C. H. Peck,** Lansingburg N. Y.

Balaninus rectus Say, chestnut weevil, adult, July; from Mrs **E. H. Mairs,** Irvington-on-Hudson N. Y.

Conotrachelus nenuphar Herbst., plum curculio, adult work on plum leaves, 12 July; from **S. B. Strong,** Setauket N. Y.

Lixus concavus Say, rhubarb curculio, adult, 5 June; from **J. H. Ball,** North Nassau N. Y.

Hylobius confusus Kirby, adult, 10 June; from **Charles Heindel,** Albany N. Y.

Hylobius pales Herbst., pales weevil, adult, 5 Nov.; from **G. W. Cravens**, Schenectady N. Y. Same, 6 May; from **C. H. Peck**, Menands N. Y.

Epicauta pennsylvanica DeG., black blister beetle, adults seriously injuring sugar beets and destroying some patches, 15 Aug.; from **J. W. Calkins**, Cobleskill N. Y. Same on potato vines and china asters, 30 Aug.; from **Ira L. Peck**, Charleston Four Corners N. Y.

Epicauta cinerea Forst., margined blister beetle, adults on anemones, 5 Aug.; from **R. M.**, Lahaska Pa.

Epicauta vittata Fabr., striped blister beetle, very numerous on beets, potatoes, beans, tomatoes, 16 Aug.; from Senator **Ambler**, Valatie N. Y. They are said to have eaten up all the beets and tomatoes and now to be devouring the potatoes.

Notoxus anchora Hentz., adults numerous around the roots of wheat, 27 June; from **C. H. Stuart**, Newark N. Y.

Pytho americanus Kirby, adults, under decaying bark, 18 Nov.; from **J. A. Otterson**, Berlin Mass.

Diaperis hydni Fabr. from Polyporus spumeus, 9 Oct.; from Mrs **Dallus**, Buena Vista Spring Pa.

Tenebrio molitor Linn., meal worm, pupae, found in a trunk, 28 May; from **George H. Hunter**, Albany N. Y. Same 23 Aug.; from **Jeanette C. Miller**, Aldercreek N. Y.

Upis ceramboides Linn., 27 May; from **Eliza S. B. Blunt**, New Russia N. Y.

Chelymorpha argus Licht., argus beetle, larvae, pupae, adults on bindweed, 23 July; from **Jeanette C. Miller**, Aldercreek N. Y.

Systena hudsonias Forst., red-headed flea beetle, adults on grape, 7 Aug.; from **J. J. Barden**, Fredonia N. Y.

Crepidodera cucumeris Harr., cucumber flea beetle, adults on bean and potato vines, 24 July; from **J. F. Hunt**, Kendaia N. Y.

Disonycha collaris Fabr., spinach flea beetle, larva on spinach, 3 July; from **G. S. Graves**, Newport N. Y.

Galerucella luteola Mill., elm leaf beetle on elm, 6 Aug.; from **Jane Bassett**, Bridgewater Mass.

Doryphora 10-lineata Say, potato beetle, work of adult on stalks of potatoes, 2 July; from **J. F. Rose**, South Byron N. Y.

Colaspis brunnea Fabr., brown Colaspis, adult on grapevine, 7 Aug.; from **J. J. Barden**, Fredonia N. Y.

Typophorus canellus Fabr., strawberry root worm, on elm, 6 June; from **Cyrus R. Crosby**, Cranberry Creek N. Y.

Chrysochus auratus Fabr., gold gilt beetle, adult, July; Mrs **E. H. Mairs**, Irvington-on-Hudson N. Y.

Fidia viticida Walsh., grape root worm, adults on grape, 10 May; from **F. M. Webster**, Euclid O. Same on grape leaves, 5 and 7 Aug.; from **J. J. Barden**, Fredonia N. Y.

Oberea bimaculata Oliv., work of raspberry cane-borer, 22 July; from Mrs **H. E. Robinson**, North Nassau N. Y.

Monohammus confusor Kirby, pine sawyer, adult, 19 July; from **W. S. Hammond**, Albany N. Y. Same July; from **C. H. Peck**, North Elba N. Y.

Rhagium lineatum Oliv., ribbed Rhagium, larva under bark of pine, 18 Nov.; from **J. A. Otterson**, Berlin Mass.

Desmocerus palliatus Forst., cloaked knotty horn, adult, July; from Mrs **E. H. Mairs**, Irvington-on-Hudson N. Y.

Plagionotus speciosus Say, sugar maple borer, adult, 23 July; from **Jeanette C. Miller**, Aldercreek N. Y.

Cyllene pictus Drury, hickory borer, adults from hickory logs, 15 Ap.; from **Eliza S. Blunt**, Brooklyn N. Y. Same 15 June; from **G. G. Atwood**, Albany N. Y.

Prionus laticollis Drury, broad-necked Prionus, adult, July; from Mrs **E. H. Mairs**, Irvington-on-Hudson N. Y.

Allorhina nitida Linn., green June beetle, adult, July; from Mrs **E. H. Mairs**, Irvington-on-Hudson N. Y.

Pelidnota punctata Linn., spotted grapevine beetle, adult on Ampelopsis, 15 July; from **J. L. Appleton**, Albany N. Y.

Anomala lucicola Fabr., light-loving grapevine beetle, adults at roots of peachtree, 28 May and July; from Mrs **E. H. Mairs**, Irvington-on-Hudson N. Y.

Lachnosterna fusca Frohl., May beetle, 27 May; from **Eliza S. Blunt,** New Russia N. Y. Larva of same on aster, 23 July; from **L. Menand,** Albany N. Y.

Geotrupes egeriei Germ., adult, 28 May; from Mrs **E. H. Mairs,** Irvington-on-Hudson N. Y.

Lucanus dama Thunb., stag beetle, adult, 19 July; from Prof. **H. P. Whitlock,** Catskill N. Y.

Ptilinus ruficornis Say, adults in maple and birch flooring, 11 July; from Dr **S. B. Ward,** Saranac Inn N. Y.

Melanotus communis Gyll., common snapping beetle, larva attacking potatoes, Feb.; from **J. C. B.,** Orange county. Same 15 June; from **G. G. Atwood,** Albany N. Y. Same July; from Mrs **E. H. Mairs,** Irvington-on-Hudson N. Y.

Alaus myops Fab., adult, 5 Oct.; from **H. N. Otterson,** Bolton Mass. Same 9 Oct.; from Prof. **F. C. Paulmier,** Rensselaerville lake, N. Y.

Alaus oculatus Linn., owl beetle, adult, 20 June; from **J. Baumgarten,** New York N. Y. Same 24 June; from **J. D. Wasson,** Altamont N. Y. Same 24 June; from **Marie Walker,** Athens N. Y. Same July; from Mrs **E. H. Mairs,** Irvington-on-Hudson N. Y. Same 10 July; from **J. F. Johnson,** Breakabeen N. Y.

Anthrenus verbasci Linn., museum pest, pupae and larvae feeding in stored silk worm cocoons and also strands of spun silk floss, 16 Feb.; from Miss **Jennie Utter,** Albany N. Y. Same adults, 17 Ap.; from **B. F. Koons,** Storrs Ct.

Anthrenus scrophulariae Linn., Buffalo carpet beetle, adults and larval skins on Zanzibar gum, 14 Nov.; from **John Wallace,** Albany N. Y.

Trogoderma ?tarsale Melsh., larval skin from old book, 5 Nov.; from **G. W. Cravens,** Schenectady N. Y.

Attagenus piceus Oliv., black carpet beetle, larva in tea, 9 Feb.; from **B. O. Burgin,** Albany N. Y. Larvae of same in stored silkworm cocoons, etc., 16 Feb.; from Miss **Jennie Utter,** Albany N. Y. Larvae of same found in garments, 26 Ap.; from Prof. **F. C. Paulmier,** Albany N. Y.

Anatis ocellata Linn., 15 spotted ladybug, larvae, pupae on American elm, 27 June; from **M. E. Woodbridge,** Binghamton N. Y. Same 6 July; from **Mary B. Sherman,** Ogdensburg N. Y.

Philonthus aeneus Rossi., adult, in garbage heap, 11 May; from Mrs **F. J. Riggs,** Albany N. Y.

Dytiscus fasciventris Say, two adults in a cistern, 18 Mar.; from **M. G. Thomas,** Schaghticoke N. Y.

Bradycellus rupestris Say, adult, 1901; from **C. A. Otterson,** Berlin Mass.

Harpalus pennsylvanicus DeG., Pennsylvania ground beetle, adult, 7 June; from **Marguerite Riggs,** Albany N. Y. Same 1901; from **C. A. Otterson,** Berlin Mass.

Harpalus erraticus Say, 27 May; from **Eliza S. Blunt,** New Russia N. Y.

Agonoderus pallipes Fabr., adult, July; from Mrs **E. H. Mairs,** Irvington-on-Hudson N. Y. Same 1901; from **C. A. Otterson,** Berlin Mass.

Calosoma calidum Fabr., fiery hunter, adult, 15 June; from **M. B. Sherman,** Ogdensburg N. Y.

Calosoma scrutator Fabr., searcher, adult, 7 June; from **F. J. Riggs,** Albany N. Y.

Cicindela punctulata Fabr., adult, 8 Feb.; from Dr **J. S. Smith,** Troy N. Y.; from Kansas.

Cicindela repanda Dej., repand tiger beetle, adult, 29 May; from **Eliza S. Blunt,** New Russia N. Y.

Cicindela formosa Say, adult, 8 Feb.; from Dr **J. A. Smith,** Troy N. Y.; from Kansas.

Cicindela audubonii Lec., adult, 8 Feb.; from Dr **J. A. Smith,** Troy N. Y.; from Kansas.

Cicindela pulchra Say, adult, 8 Feb.; from Dr **J. A. Smith,** Troy N. Y.; from Kansas.

Tetracha carolina Linn., adult, 8 Feb.; from Dr **J. A. Smith,** Troy N. Y.; from Kansas.

Diptera

Melophagus ovinus Linn., sheep tick, adult, 1901; from **C. A. Otterson**, Berlin Mass.

Rhagoletis cingulata Loew., cherry fruit fly, adults and puparia on cherries, 24 July; from **J. F. Hunt**, Kendaia N. Y.

?Phorbia fusciceps Zett., fringed anthomyian, work on seedling beans, 7 July and 1 Aug.; from **J. F. Rose**, South Byron N. Y.

Pegomyia affinis Stein., from **J. M. Aldrich**, Moscow, Idaho; from Algonquin Ill.

Stomoxys calcitrans Linn., stable fly on window, 22 Nov.; from Mrs **F. J. Riggs**, Albany N. Y.

Sarcophaga? sp., flesh fly, adult, 14 Sep.; from **W. C. Hitchcock**, Pittstown N. Y.

Cuterebra cuniculi? Clark, the rabbit botfly, larva from a kitten, 19 Aug.; from **D. T. Meskil**, Highland Falls N. Y. Same from Belgian hare, 8 Aug.; from **Fred Harris**, New York.

Hypoderma lineata Villers, warble fly, nearly full grown larvae on cattle, 13 Ap.; from **G. S. Graves**, Newport N. Y.

Eristalis tenax Linn., drone fly, pupae in water, 9 July; from **S. T. Hudson**, Riverhead N. Y.

Tabanus reinwardtii Wied., adult, June 5; from Dr **J. Benton Tipton**, Albany N. Y. Same 10 June; from **Charles Heindel**, Albany N. Y.

Chrysops excitans Walk., adult, 5 June; from Dr **J. Benton Tipton**, Albany N. Y.

Bibio albipennis Say, white winged Bibio, adults on herbage, 29 May; from **Eliza S. Blunt**, New Russia N. Y.

Rhabdophaga salicis Schrk., pupae, adults on basket willow, 1 June; from **H. C. Peck**, Rochester N. Y.

Cecidomyia destructor Say, Hessian fly, pupae on grain, 5 and 11 June; from **C. H. Stuart**, Newark N. Y. Same on wheat, 13 June; from **J. F. Hunt**, Kendaia N. Y. Same on wheat 17 or 18 June; from Mrs **A. M. A. Jackson**, Belle Isle N. Y.

Lepidoptera

Basilarchia archippus Cram., viceroy, 2d stage larva on apple, 19 July; from **P. L. Huested**, Highland N. Y.

Phyciodes tharos Drury, adult, 15 July; from **W. C. Hitchcock**, Pittstown N. Y.

Eugonia j-album Bd.-Lec., Compton tortoise, adult, 21 Aug.; from **G. S. Graves**, Newport N. Y.

Euvanessa antiopa Linn., spiny elm caterpillar, larva on willow, 17 Sep.; from **G. S. Graves**, Newport N. Y.

Cyaniris ?pseudargiolus Bd.-Lec., larva on apple, 4 June; from **Harriet W. Smith**, North Hector N. Y.

Jasoniades glaucus Linn., tiger swallowtail, adult, 15 July; from **W. C. Hitchcock**, Pittstown N. Y.

Heraclides cresphontes Cram., giant swallowtail, 3 larvae on prickly ash, July 8; from **P. W. King**, Athens N. Y. Same on fraxinella, 12 July; from **C. A. Deyo**, Schoharie N. Y. Same on orange, 16 July; from **Virgil Bogue**, Albion N. Y. Same on hop hornbeam, July; from Gen. **J. H. Patterson**, Selkirk N. Y. Adult of same, 23 Aug.; from Mrs **Abram Lansing**, Albany N. Y. Larva of same on fraxinella, 11 Sep.; from **Alice G. Fisher**, Batavia N. Y. Same on Dictamnus fraxinella, 17 Sep.; from **O. A. Lansing**, Albany county.

Papilio polyxenes Fabr., black swallowtail, larva on caraway, 3 July; from **G. S. Graves**, Newport N. Y.

Amphion nessus Cram. adult, 12 June; from **O. Q. Flint**, Athens N. Y.

?Thyreus abbotii Swain., the abbot sphinx, young larva on ampelopsis, 15 July; from **R. Thompson**, Ballston Spa N. Y.

Deilephila lineata Fabr., the white lined sphinx, adult on flowers, 26 Aug.; from **F. L. Lill**, East Bethlehem N. Y.

Philampelus pandorus Hübn. pandorus sphinx; larva (parasited) on ampelopsis, 9 Sep.; from **Cyrus R. Crosby**, Cranberry Creek N. Y.

Ampelophaga myron Cram., green grapevine sphinx, larva on grapevine, 10 July; from **T. W. King**, Athens N. Y.

Same on Virginia creeper, 11 Aug.; from **Jeanette C. Miller,** Aldercreek N. Y.

Phlegethontius celeus Hübn., tomato or potato worm, pupa in soil, 9 May; from **G. F. Bixby,** Plattsburg N. Y. Same 23 May; from **G. S. Graves,** Newport N. Y.

Phlegethontius carolina Linn., tobacco worm, larva on potato, 18 July; from **C. C. Hardenbergh,** Stoneridge N. Y.

Alypia octomaculata Hübn., eight spotted forester, larva on Virginia creeper, 22 July; from Mrs **H. E. Robinson,** North Nassau N. Y. Same 30 July; from **Jeanette C. Miller,** Aldercreek N. Y.

Arctia virguncula Kirby, adult, 15 July; from **W. C. Hitchcock,** Pittstown N. Y.

Spilosoma virginica Fabr., yellow woolly bear, adult in spider's web, 15 July; from **G. S. Graves,** Newport N. Y. Same 15 July; from **W. C. Hitchcock,** Pittstown N. Y. Same July; from Mrs **E. H. Mairs,** Irvington-on-Hudson N. Y.

Hyphantria cunea Drury, fall webworm, adult, 15 July; from **W. C. Hitchcock,** Pittstown N. Y. Same on catalpa, 27 Aug.; from **C. L. Allen,** Floral Park N. Y. Same 5 Sep.; from **Hiram Van Slyke,** Coxsackie N. Y. Same on many trees and shrubs, 5 Sep.; from Mrs **E. H. Mairs,** Irvington-on-Hudson N. Y.

Notolophus ?antiqua Linn., egg on apple, 11 May; from **B. D. Van Buren,** Plattsburg N. Y.

Notolophus leucostigma Abb. & Sm., white marked tussock moth, male, July; from Mrs **E. H. Mairs,** Irvington-on-Hudson N. Y. Same, female and recently laid eggs, 2 Oct.; from **M. W. Van Denburg,** Mount Vernon N. Y. Larvae were abundant the last three weeks of September, the females beginning to spin up the last week of September.

Sibine stimulea Clem., saddle back caterpillar, larvae, 24 Aug.; from **O. Q. Flint,** Athens N. Y. Same on beet leaves, 17 Sep.; from **J. B.,** Greenwich Ct.

Datana ministra Drury, yellow necked appletree caterpillar, larvae on quince, 10 Aug.; from **C. H. Peck,** Menands N. Y.

Datana integerrima Gr. & Rob., larvae on walnut, 6 Aug.; from **Washington Rodman**, Astoria N. Y. Same larvae and pupae on hickory 13 and 21 Aug.; from **B. F. Koons**, Storrs Ct. Same 31 Aug.; from **Leigh I. Holdredge**, Oneonta N. Y.

Schizura concinna Abb. & Sm., red humped appletree worm, larva on apple 22 July; from Mrs **H. E. Robinson**, North Nassau N. Y. Same 30 July from **H. D. Lewis**, Annandale N. Y.

Samia cecropia Linn., cecropia moth, adult, 21 June; from **Mary B. Sherman**, Ogdensburg N. Y. Same 2 July; from **Minnie Green**, Albany N. Y.

Automeris io Fabr., io moth, adult, 13 June; from **J. P. Van Ness**, East Greenbush N. Y. Same larva, 23 July; from **Harriet M. Smith**, North Hector N. Y. Same larvae on apple, 26 July; from **V. P. D. Lee**, Altamont N. Y.

Anisota senatoria Abb. & Sm., orange striped oak worm, larva dead on pin oak (Quercus palustris) 30 Aug.; from **L. Menand**, Albany N. Y.

Clisiocampa americana Fabr., appletree tent-caterpillar, adult, 15 July; from **W. C. Hitchcock**, Pittstown N. Y. Same, adult, July; from Mrs **E. H. Mairs**, Irvington-on-Hudson N. Y.

Clisiocampa disstria Hübn., forest tent-caterpillar, larvae on apple, 11 May; from **G. F. White**, Preston Hollow N. Y. Same, larva, on elm 30 May; from **Rhoda Thompson**, Ballston Spa N. Y. Same, cocoons, 30 July; from **H. D. Lewis**, Annandale N. Y.

Tolype laricis Fitch, larch lappet caterpillar from under a plumtree, 30 July; from **J. H. Clark**, Coldwater N. Y.

Prionoxystus robiniae Peck, oak carpenter moth, larvae in sugar maples, 1 Dec.; from **Mary B. Sherman**, Ogdensburg N. Y. Over 20 half and full grown larvae were taken from one tree. Same, larvae in ash trunk, 8 June and adults, 28 June; from **M. F. Adams**, Buffalo N. Y.

Zeuzera pyrina Fabr., leopard moth, larva in imported quince seedlings, 29 Jan.; from **C. H. Stuart**, Newark N. Y.

Mamestra picta Harr., zebra caterpillar, larvae on red raspberry, 20 June; from **F. J. Hunt**, Kendaia N. Y.

Hydroecia nitela Guen., stalk-borer, larva on raspberry, 17 July; from Mrs **H. E. Robinson**, North Nassau N. Y.

Euthisanotia grata Fabr., beautiful wood nymph, moth, 15 July; from **W. C. Hitchcock**, Pittstown N. Y.

Plusia balluca Geyer, adult, 15 July; from **W. C. Hitchcock**, Pittstown N. Y.

Plusia simplex Guen., celery plusia, larvae on celery, 14 Oct.; from **L. Balderston**, Colora Md.

Catocala amatrix Hübn., adult, 14 Sep.; from **W. C. Hitchcock**, Pittstown N. Y.

Paleacrita vernata Pack., spring canker worm, eggs, larvae on appletree, 6 May; from **J. F. Hunt**, Kendaia N. Y. The eggs were just hatching, and the living female received deposited a number of eggs.

Alsophila pometaria Harr., fall canker worm, larvae on apple, 15 May; from Mrs **A. M. A. Jackson**, Belle Isle N. Y.

Evergestis stramenalis Hübn., black headed cabbage worm, larva on turnip, 3 and 13 July; from **G. S. Graves**, Newport N. Y.

Plodia interpunctella Hübn., Indian meal moth, all stages in a box of roasted oats, 18 Feb.; from Mrs **F. J. Riggs**, Albany N. Y.

Cacoecia ?rosaceana Harr., oblique banded leaf-roller, adult, July; from Mrs **E. H. Mairs**, Irvington-on-Hudson N. Y. Same, larvae on maple, 6 Aug.; from **Hugh P. Blackinton**, Hoosick Falls N. Y.

Tmetocera ocellana Schiff., bud moth, larvae on apple, 15 May; from Mrs **A. M. A. Jackson**, Belle Isle N. Y.

Phoxopteris nubeculana Clem., apple leaf-folder, larva on apple, 27 Oct.; from **J. Jay Barden**, Fredonia N. Y.

Carpocapsa pomonella Linn., codling moth, larva on quince, 12 July; from **S. B. Strong**, Setauket N. Y.

Sitotroga cerealella Oliv., grain moth, all stages in a cereal, 11 Mar.; from **Albany camera club**, Albany N. Y.

Ornix geminatella Pack., mines in apple leaves, 29 Oct.; from **J. Jay Barden**, Fredonia N. Y. They were so abundant that there was scarcely a perfect leaf in the orchard.

Coleophora malivorella Riley, pistol case-bearer, larvae on appletree, 6 May; from **J. F. Hunt**, Kendaia N. Y.

Coleophora limosipennella Dup., larvae on European elm, 15 June; from **E. T. Schoonmaker**, New York N. Y

?Catastega aceriella Clem., work of larvae on hard maple, 13 Aug.; from **Jeanette C. Miller**, Aldercreek N. Y.

Lithocolletis pomifoliella Zell., thorn apple leaf-miner, mines in apple leaves, 29 Oct.; from **J. Jay Barden**, Fredonia N. Y.

Bucculatrix canadensisella Cham., birch leaf Bucculatrix, larvae and pupae very abundant on birch, 3 Sep.; from **Mrs H. D. Gravès**, Ausable Forks N. Y. Same, larvae on white birch, exceedingly abundant, 11 Sep.; from **Mary B. Sherman**, Ogdensburg N. Y.

Mecoptera

Panorpa confusa Westw., scorpion fly, adults taken at Sandusky O., 29 June; from **J. S. Hine**, Columbus O.

Panorpa venosa Westw., scorpion fly, adults taken at Hanging Rock O., 27 June; from **J. S. Hine**, Columbus O.

Bittacus punctiger Westw., adults, taken in District of Columbia, 18 July; from **J. S. Hine**, Columbus O.

Bittacus apicalis Uhl., adults taken at Sandusky O., 12 July; from **J. S. Hine**, Columbus O.

Neuroptera

Chauliodes pectinicornis Linn., adults, 15 July; from **W. C. Hitchcock**, Pittstown N. Y.

Corydalis cornuta Linn., horned Corydalis, adult, 5 July; from **F. S. Tinney**, Albany N. Y. Same, 10 July; from **A. T. Laird**, Albany N. Y. Same, adult, 15 July; from **A. H. Green**, Shushan N. Y. Same, adult, 15 July; from **H. D. Lewis**, Annandale N. Y.

Hemiptera

Acanthosoma cruciata? Say, last nymphal stage, on hemlock, 20 Aug.; from **Eliza S. Blunt**, summit of Mt Hurricane, N. Y.

Anasa tristis DeGeer, squash bug, eggs, adults on squash, 29 June; from Schoharie county. Same, 10 July; from **Rhoda Thompson**, Ballston Spa N. Y.? Work of same and first nymphal stage, on squash or melon, 15 Aug.; from Mrs **C. C. Woolworth**, Castleton N. Y. Nymph of same, 19 Aug.; from **George S. Graves**, Newport N. Y.

Blissus leucopterus Say, chinch bug, adult on timothy, 7 Sep.; from **James M. Graff**, Westport N. Y.

Leptopterna dolobrata Linn., adults, on wheat, 27 June; from **C. H. Stuart**, Newark N. Y.

Lygus pratensis Linn., tarnished plant bug, 8 Sep.; from Miss **Eliza S. Blunt**, New Russia N. Y.

Poecilocapsus lineatus Fabr., four lined leaf bug, adults on chrysanthemum, 26 June; from **E. T. Schoonmaker**, Cedar Hill N. Y.

Triphleps insidiosus Say, 8 Sep.; from Miss **Eliza S. Blunt**, New Russia N. Y.

Acanthia lectularia Linn., bed bug, adult, 19 Feb.; from **John Wallace**, Albany N. Y.

Phymata wolffii Stal., ambush bug, adult, 12 Aug.; from **G. A. Baily**, Cardiff N. Y.

Emesa longipes DeGeer, thread legged bug, adult, 16 Sep.; from **O. Q. Flint**, Athens N. Y.

Benacus griseus Say, giant water bug, adult, 17 June; from Mrs **M. B. Witherell**, Shushan N. Y.

Typhlocyba comes var. vitis Harr., grapevine leaf hopper, cast skins on grape leaves, 15 Nov.; from **Alice M. Gardner**, Fulton N. Y.

Poeciloptera septentrionalis Spin., grape Poeciloptera, adult accidentally on celery, 14 Oct.; from **L. Balderston**, Colora Md.

Ormenis pruinosa Say, lightning leaf hopper, young on pear, currant, ? plantain, 10 July; from **G. S. Clark**, Milton N. Y. Nymph of same on grape, 24 July; from **J. F. Hunt**, Kendaia N. Y.

Enchenopa binotata Say, two spotted tree hopper, adults on bittersweet, 30 July; from Dr **Henry Coffin**, Glens Falls, N. Y.

Haematopinus eurysternus Nitzs., short-nosed cattle louse, eggs and adults on cattle hairs, 6 Feb.; from Dr **C. D. Smead** Ohio.

Phylloxera caryaecaulis Fitch, hickory gall aphis, all stages in hickory galls, 8 June; from **H. N. Howe**, Bedford Station N. Y.

Phylloxera vitifoliae Fitch, grape Phylloxera, galls on grape leaves, 7 Sep.; from Miss **M. L. Williams**, Sherburne, N. Y.; adults and young of same in grape galls, 27 Sep.; from **J. Jay Barden**, Fredonia N. Y.

Pemphigus tessellatus Fitch, alder blight, on German alder (imported) and the native species 24 June; from **H. C. Peck**, Rochester N. Y.

Schizoneura americana Riley, woolly elm aphis, young and adults on American elm, 30 May; from **Rhoda Thompson**, Ballston Spa N. Y.

Phyllaphis fagi Linn., beech aphis, on red beech, 20 June; from Mrs **C. J. Gould**, Tarrytown N. Y.

Callipterus ulmifolii Monell, elm leaf aphis, exuviae on American elm, 27 June; from **M. E. Woodbridge**, Binghamton N. Y. Same 15 June; from **A. H. Wright**, Rome N. Y.

Myzus cerasi Fabr., cherry aphis, all stages on cherry, 12 June; from **C. A. Wieting**, Cobleskill N. Y.

Myzus ribis Linn., currant aphis, females on currant, 4 May; from **L. I. Holdredge**, Oneonta N. Y. Young of same, 1 June; from **J. B. Rice**, Cambridge N. Y. Same, 12 June; from **C. A. Wieting**, Cobleskill N. Y.

Chionaspis euonymi Comst., on Celastrus scandens, 20 Dec.; from **P. L. Huested**, Blauvelt N. Y.

Chionaspis furfura Fitch, scurfy bark louse, adults and eggs on baldwin apples (fruit), 24 Nov.; from ? **C. J. Lisk**, New Baltimore N. Y.

Chionaspis ?lintneri Comst., on Cornus, 19 Mar.; from **H. C. Peck**, Rochester N. Y. Probably same, 15 Sep.; from **P. L. Huested**, Buffalo N. Y.

Chionaspis pinifoliae Fitch, pine leaf scale insect, adults on white pine needles, 30 Oct.; from **Spencer Trask**, Saratoga Springs N. Y.

Mytilaspis pomorum Bouché, appletree bark louse, eggs under scales on Pennsylvania maple, 10 Feb., eggs of same on Crataegus, 1 June, and young on apple, 8 June; all from **G. S. Graves**, Newport N. Y. Eggs of same on apple, 15 Ap.; from **C. E. Childs**, Mayfield, N. Y. 4 May; from **W. M. Phipps**, Albion N. Y. 9 May; from **Cyrus Crosby**, Cranberry Creek N. Y. Eggs of same on lilac, 9 May; from **C. A. Hall**, Oak Hill N. Y. Probably same on syringa imported from Germany, 24 June; from **H. C. Peck**, Highland park, Rochester N. Y. Same on ash, 30 Aug.; from **J. T. Gaylord**, Poughkeepsie N. Y.

Parlatoria viridis Ckll., on Japanese maple, 26 Ap.; from **H. C. Peck**, Rochester N. Y.

Aulacaspis rosae Sandb., rose scale, on blackberry, 27 Mar.; from **J. Jay Barden**, Stanley N. Y. Same with eggs, on black raspberry, 10 May; from **William Trimble**, Concordville Pa. Same on blackberry, 3 June; from Hudson N. Y.

Diaspis cacti Comst. cactus scale, all stages on night blooming cereus, Cereus grandiflora, 7 Nov; from **L. H. Joutel**, New York N. Y.

Aspidiotus ancylus Putn., Putnam's scale, on nectarine and pear, 10 May; from **Edward Moore**, Loudonville N. Y. Same on apple, 24 June; from **B. D. Van Buren**, Union Springs N. Y. Same, adults and young on purple-leafed beech, 26 July; from **P. L. Huested**, Menands N. Y. Same on mountain ash, 6 Aug. from **H. C. Peck**, Rochester N. Y.

Aspidiotus forbesi Johns., cherry scale on Japan plum, 10 June; from **D. C. Lee**, Cornwall N. Y. Same on apple, 30 Aug.; from **P. L. Huested**, Crescent Station N. Y.

Aspidiotus ostreaeformis Curt., English fruit tree scale insect, on apple, 6 June; from **B. D. Van Buren**, Union Springs N. Y. Same with probably some A. ancylus on currant, 15 June; from **C. H. Darrow**, Geneva N. Y. Adult female of same, on ? willow and ? plum, 16 July from **Mr Van Buren**, Scipioville N. Y. Adults and young of same on willow, 20 July, and adults of same, on Carolina poplar, 5 Aug.; from **J. Jay Barden**, Fredonia N. Y. Same on plum, 6 Aug.; from **H. C. Peck**, Rochester N. Y.

Aspidiotus perniciosus Comst., San José scale, breeding on peach, 19 Oct.; from **E. M. Wilson**, Babylon N. Y. Same on Japan plum, 27 Nov.; from **A. M. Halstead**, Rye N. Y. Young of same on plum, 25 Feb.; from Dr **Edward Moore**, Loudonville N. Y. Young of same on apple, 29 Ap.; from **J. A. Hepworth**, Marlboro N. Y. 13 July; from **L. L. Morrell**, Kinderhook N. Y. Same on Japan quince, 6 May; from **J. A. Paine**, New York N. Y. Same, half grown, on flowering prune, 8 June; from **H. N. Howe**, Bedford Station N. Y., through *Country gentleman*. Same on Japan plum, 17 June; from **L. F. Brown**, near Highland N. Y.

Aspidiotus uvae Comst., on grapevine, 26 Mar.; from **J. L. Cooper**, Nashville Tenn., through *Country gentleman*.

Asterolecanium variolosum Ratz., golden-oak scale, on white oak, 16 Sep.; from **I. O. C.**, Yonkers N. Y., through *Country gentleman*.

Lecanium cerasifex Fitch, cherry Lecanium on apple, 25 Mar.; from **M. H. Beckwith**, Elmira N. Y.

Lecanium hesperidum Linn., young and adults on fern, 22 Mar.; from **J. D. Winne**, Kingston N. Y. Same on orange, 19 Aug.; from **J. W. Knapp**, Warwick N. Y.

Lecanium ? prunastri Fonsc., New York plum Lecanium, young on plum, 13 Ap.; from **M. H. Beckwith**, Elmira N. Y. 22 June; from **C. H. Darrow**, Geneva N. Y.

Gossyparia ulmi Geoff., Elm bark louse, adult on elm, 17 June; from **H. C. Peck**, Rochester N. Y.

Orthoptera

Oecanthus niveus DeGeer, white flower cricket, eggs in raspberry canes, 31 Dec.; from **C. G. Babcock**, Newport N. Y. Eggs of same in peach twigs, 7 Feb.; from **H. C. Peck**, Scottsville N. Y. Adult of same, 14 Sep.; from **W. C. Hitchcock**, Pittstown N. Y.

Microcentrum retinervis Burm., angular winged katydid, eggs, on plum, 18 June; from Austin W. Va., through **Vick publishing co.** Rochester N. Y.

Diapheromera femorata Say, walking stick, adult, 26 Oct.; from **Harry W. Riggs**, Albany N. Y.

Mantis religiosa Linn., praying mantis, 127 egg cases on grass stalks, etc., 8 Ap.; from **H. F. Atwood**, Rochester N. Y.

Ischnoptera pennsylvanica DeGeer, wood cockroach, young in decayed wood, 31 Jan.; from **Henry L. Griffis**, Newpaltz N. Y.

Nyctoboro ?holosericea Klug., young probably on bananas, 13 Ap.; from **J. M. Dolph**, Port Jervis N. Y.

Corrodentia

Psocus venosus Burm. on maple, 13 Aug.; from **B. F. Koons**, Storrs Ct.

Thysanura

Thermobia furnorum Rov., silver fish, adult among papers, etc., 5 Nov.; from **G. W. Cravens**, Schenectady N. Y.

Smynthurus hortensis Fitch, garden flea, adults on melon and squash, 31 May; from **C. E. Ford**, Oneonta N. Y.

Arachnida

Phytoptus ulmi Garm., elm gall mite on American elm, 8 June; from **G. S. Graves**, Newport N. Y.

Appendix

ACCOUNT AND CATALOGUE OF THE ENTOMOLOGIC EXHIBIT AT THE PAN-AMERICAN EXPOSTION 1901

Official awards

Gold medal. Collective exhibit of insects

Silver medals. Forest and shade tree insects; entomologic technical collection; wing frame exhibit showing work of entomologist.

Several things were kept in mind in the preparation of this collection. It was designed primarily to be of the greatest possible value to all those who are obliged to control insects or suffer financial loss; and, to accomplish this, insects injurious to the different crops and to various products were given a very prominent place in the exhibit. These injurious species are also represented, so far as possible, in their different stages, egg, larva, pupa and adult, and any peculiarities of habit (specially those bearing on the character of the injury) are illustrated. Thus in looking over the exhibit of injurious forms, the visitor has before him an epitome of the life of the depredator. He sees not only the insect in its injurious stage but also in its other forms, and in a few moments he can grasp many of the essential facts in the life history of a pest. The illustrations of the work of the injurious species are frequently very helpful in enabling a farmer to recognize the author of what was to him previously a mysterious injury. A catalogue of the collection was also prepared, and its value much enhanced by the addition of references to the principal notices of economic groups and also of individual species, thus making it practically a reference book to the latest and most accessible accounts of the various pests represented, and, in addition to

this, brief directions are given for controlling the various forms. The enormous number of injurious insects, even in New York state, made it imperative that the exhibit should be limited to the more important forms, and that the insects selected be grouped in a manner easily comprehended by the general public; they are therefore arranged under various important food plants, etc., and each group receives special notice under an appropriate head.

There are many who are interested in insect life for other than économic reasons. Students of entomology will find much of interest in the systematic collection, in which are native representatives of all the more important families, and beginners will derive much aid in the care of their specimens from a study of the technical collection. Those attracted by the peculiar or beautiful in nature will find much of interest in the collection of the work of gall insects, in the mimicry collection and in the collection of New York beauties, the latter being an assemblage of some of the more beautiful native butterflies and moths. The wing frames and framed photographs present by means of statistics and illustrations some of the more important activities of the office. The entire exhibit can now be seen at the state museum, Albany N. Y.

Fruit tree insects (nos. 1-23). This collection of 23 different species includes some of the most important insect enemies of man, such as the codling moth, a species causing an estimated annual loss in New York state alone of about $3,000,000, the plum curculio, appletree borers (both exceedingly destructive), rose beetle, appletree tent-caterpillar, case-bearers and others, all insects causing much loss annually to fruit growers. Many of these pests have been repeatedly noticed in the reports and bulletins issued by the state entomologist, and, for excellent accounts of individual species, the reader is referred to the citations given in the appended catalogue.

Vine and small fruit insects (nos. 24-41). This group comprises 18 of the most injurious forms depredating on the grapevine, currant, raspberry and other small fruits. One of the most important species represented is the grapevine root worm, a

beetle which has already caused considerable loss in the western part of the state and one which threatens to do much injury in the future. The grapevine flea beetle is another pest which demands special mention in this connection. The grapevine plume moth, the currant sawfly and the tarnished plant bug are all familiar in a way to many growers, and yet few comprehend fully the actual mischief they cause. Many of those included in this and following groups have been figured and briefly described in bulletin 37 of the New York state museum.

Garden insects (nos. 42-68). This group is represented by 27 species which injuriously affect one or more of the crops commonly grown in gardens. In it are found such notorious pests as wireworms, cutworms, cabbage butterfly, blister beetles, cucumber beetles, flea beetles, asparagus beetles, squash bugs, etc. Many of them are very common, and not a few are exceedingly destructive, in spite of the fact that in most cases there are a number of well-known methods of keeping these pests in control. Most of these forms are treated of in the reports of the state entomologist, and many of them in the state museum bulletin 37, cited above.

Grass and grain insects (nos. 69-83). This group contains only 15 species, but in it are represented some exceedingly destructive insects. The June beetles, or white grubs, are probably as destructive as some of the species feared much more, but, as the injury they cause is usually a constant one, it attracts little attention as a rule. The army worm outbreak of 1896 is still fresh in the minds of many, while the Hessian fly has this year caused an estimated loss in New York of $3,000,000, or about half the crop. The chinch bug is another of the notorious enemies to prosperity, proving most injurious in the southern and western states, though in 1882 and 1883 it threatened to cause considerable loss in New York state. A very good account of this outbreak is given by the late Dr Lintner in his second report as state entomologist. A number of species of grasshoppers are also included, since they not infrequently cause great mischief in various sections of the state.

Household insects (nos. 84-99). The species represented in this group are but 16 in number, yet many a housewife would prefer to fight two or three less prolific pests, rather than any one of several which may be named in the list. Recent investigations have shown that not only is the common house fly a nuisance about the house, but also that it is a menace to the good health of the community. A reduction of its numbers is comparatively easy. The cheese skipper, noticed in detail in the 12th report of the state entomologist, is of much interest to cheese makers. The croton bug, cockroach, carpet beetles, clothes moths and other familiar pests in the home have been treated briefly by the state entomologist in the transactions of the New York state agricultural society for 1899.

Insects affecting stored food products (nos. 100-8). This small group, comprising but nine species, includes some very injurious forms. The most important are, the grain moth (a species which has caused considerable injury to wheat on Long Island and adjacent localities last year and this), the bean weevils and the cigarette beetle. Most of these insects breed readily in various dried food products and not infrequently they are sources of annoyance in the house. Most of these species have been briefly treated in bulletin 37 of the New York state museum.

Beneficial insects (nos. 109-63). This is an exceedingly important group which is represented in the collection by 55 different species. A series of forms which carry pollen from one plant to another is shown in order to emphasize this function of insects. It may well be considered as one of the most important exercised by them. A few of the many beneficial parasites and predaceous enemies of insects are included, so that the farmer and others may have some idea of the appearance of beneficial forms. The mulberry silkworm and some of its allies comprise the portion of this group devoted to species of direct value or benefit to man.

Scale insects, Coccidae (nos. 164-202). This exceedingly important group differs so widely from all other insects that its

members were brought together in one collection, that the comparative differences between them might be more easily seen. The 39 species represented include, among others, the two very common and injurious forms known as the appletree bark louse and the scurfy bark louse. The notorious San José scale insect is well represented, and its close allies, the English fruit tree scale insect, the cherry scale insect and Putnam's scale insect, also find a place in the collection. These more important enemies of fruit trees have been treated of in considerable detail and admirably illustrated in colors in bulletin 46 of the New York state museum. Another very important scale insect included here is the elm bark louse, a species which is noticed in some detail and illustrated in colors in the 5th report of the fisheries, game and forest commissioners of New York.

Forest insects (nos. 203-51). This very important group is represented in the collection by 49 species, the result mostly of recent collections made in the state. Dr A. D. Hopkins, who is a recognized authority on this subject, estimates the total annual loss caused by insects in this country in forest and forest products at the enormous sum of $25,000,000. This is a group to which comparatively little attention had been paid in New York till the state entomologist took up the study of it several years ago. Among the more important forms represented in this collection may be mentioned the pine "sawyer," a large grub which frequently causes much injury to logs allowed to lie for some time in mill yards. A number of species of bark-borers are represented. They are of special interest, because several of them are quite injurious to soft woods in the Adirondacks, while other species are killing pine in the Hudson river valley and on Long Island. The forest tent-caterpillar, the pest which has been ravaging our hard maples in recent years, is well represented in the collection, along with some of its natural enemies. A summary account of this insect, illustrated by colored figures, has been given by the state entomologist in the 4th report of the fisheries, game and forest commissioners of New York.

Shade tree insects (nos. 252-67). This group, illustrated by 16 species, naturally comes very close to the preceding. It has been limited largely in the present instance to those species which are rarely of economic importance except when attacking shade trees; and, as these are among our most valuable assets, the group is of great economic importance. It includes such destructive pests as the sugar maple borer, leopard moth, elm bark borer, elm bark louse, elm leaf beetle, white marked tussock moth, bag worm, and others, all very injurious to highly prized shade trees. Most of them can be controlled without excessive expense. For detailed accounts of these pests the reader is referred to the New York state museum bulletins 20 and 27, to the 12th report of the state entomologist and to his papers in the 4th and 5th reports of the fisheries, game and forest commissioners of New York.

Work of gall insects (nos. 268-97). This is a small collection of deformities produced in plants by 30 species of insects belonging to three different orders. It illustrates the effect a comparatively insignificant insect may have on plant tissues, and in the study of the collection a number of interesting biologic problems are presented to the mind of the student.

Systematic collection (nos. 298-931). This assemblage of 634 species occupies nearly one third of the entire space devoted to the display of insects. It is arranged according to what are believed to be the natural affinities of the species. That is, the more closely related are put next to each other, so far as possible. There is nothing very new in the collection, but it accomplishes its object in giving the casual observer some idea of the immense number and variety of forms found in the insect world. Such a collection can make no pretense to completeness, as will be seen at once, when it is remembered that our best authorities estimate that between one and 10 million different species of insects now exist in the world. It has special value, however, to residents of New York state, since the more common native forms are very fully represented. This is of particular advantage in showing to some extent how many insects occur in a locality,

and the sight of these should serve as a stimulus to the young collector. This part of the exhibit should also aid materially in the identification of native forms by comparison. The common names of orders, families, groups and species, where well recognized ones occur, have received a prominent place, so that the nonscientific may not be discouraged by labels bearing only unfamiliar Latin names, and those who will use only scientific names, will find them readily, even though written in smaller characters. A more definite idea of this collection may be obtained by the following figures. The bee and the wasp family is represented by 67 species, beetles, by 213 species, two winged flies (Diptera) by 55 species, butterflies, by 69 species, moths, by 106 species, true bugs, by 44 species (to which should be added the 39 species of scale insects put in a special collection) and the grasshopper family, by 20 species. The smaller orders like the fleas, caddis flies, Thrips, white ants, stone flies, dragon flies, May flies, etc., are represented by relatively fewer species. This part of the exhibit contains by far the largest number of species, and, in order to get the most out of it, considerable time should be given to the groups most interesting to the individual observer.

Collection illustrating protective mimicry (nos. 932-46). This is a small lot, comprising but 15 species. It is an exceedingly pretty assemblage of insects, and, though individuals may disagree as to the method by which such interesting adaptations are brought about, no one can fail to admire the collection as a whole and to be interested in the striking illustrations of protective mimicry.

New York beauties (nos. 947-61). This small assemblage of only 15 native species was brought together for the purpose of showing some of the beautiful forms occurring in our state.

Technical collection (nos. 962-1021). This consists of over 60 different articles arranged to show the best methods and apparatus for the collection and preservation of insects. It is an exceedingly important subject to the amateur entomologist; and, as most of the articles exhibited are comparatively inexpensive, and as many homemade devices are included in the collection,

this portion of the exhibit can not fail to be of interest and of great practical value to those making collections of insects.

Framed photographs (nos. 1022-26). This series is largely historical in nature, as enlarged photographs of the two early official entomologists of the state and the residence and work building, or "bug house," of the New York pioneer in economic entomology occupy prominent places in the collection. While all of these are of importance, because the public should be interested in the features of prominent scientific men, the two latter photographs are exceedingly valuable, because they constitute a graphic record of the conditions under which the study of insects was first pursued by a New York state official.

Wing frames (1027-52). The tables and illustrations displayed on the wing frames give a general idea of the main activities of the office. Besides organization, list of publications, table of correspondence, etc., most of the wing frames are occupied with some of the more important original illustrations prepared in the office, thus giving in a graphic manner some idea of the number and variety of insects studied.

Publications. This exhibit includes all of the more important publications of the state entomologist and his predecessor, the entomologist of the New York state agricultural society. The Fitch reports, as they are commonly termed, and the reports of the state entomologist contain many detailed, illustrated notices of our most important insect pests. The entomologic bulletins of the state museum, except a few of the later ones devoted to the report of the entomologist, usually treat of a well related group and are as a rule of more service to the practical, non-entomologic person than independent notices in various reports or in separate bulletins. The reference to the more accessible, important notices of injurious insects listed in the appended catalogue should prove invaluable in directing the general public to the desired information in these reports and bulletins.

A copy of the catalogue is appended to this account and should be consulted for further information in regard to the collection.

CATALOGUE

FRUIT TREE INSECTS (1-23)

General works on the group

Fitch, Asa. Noxious and other insects of New York. 3d rep't, '56. p. 3-119.

Saunders, William. Insects injurious to fruits. Lippincott. Phila. '89. p. 1-436.

Weed, C. M. Insects and insecticides. Published by the author, Hanover N. H. '91. p. 1-281.

Smith, J. B. Economic entomology. Lippincott. Phila. '96. p. 1-481.

1 **Codling moth,** Carpocapsa pomonella Linn. Principal food plants: apple, pear.

Treatment: Spray with poison soon after the petals have fallen, destroy fallen fruit, trap larvae under bands.

Chief accessible articles: **Comstock, J. H.** U. S. dep't agric. Rep't, '79. p. 253-55; **Howard, L. O.** —— '87. p. 88; **Lintner, J. A.,** state ent. 9th rep't, '92. p. 338-42; **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 142. '98. p. 1-69; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59: 276-77.

2 **Bumble flower beetle,** Euphoria inda Linn. Principal food plants: peaches, corn.

Treatment: hand picking.

Chief accessible article: **Lintner, J. A.,** state ent. 1st rep't, '82. p. 232-39.

3 **Plum curculio,** Conotrachelus nenuphar Herbst. Principal food plant: plum.

Treatment: Destroy the beetles after jarring them from the trees.

Chief accessible articles: **Riley, C. V.** and **Howard, L. O.** U. S. dep't agric. Rep't, '88. p. 57; **Lintner, J. A.,** state ent. 7th rep't, '91. p. 288-96.

4 **Pear midge,** Diplosis pyrivora Riley. Principal food plant: pear.

Treatment: Destroy infested fruit before maggots escape.

Chief accessible articles: **Riley, C. V.** U. S. dep't agric. Rep't, '85. p. 283-89; **Lintner, J. A.,** state ent. 8th rep't, '91. p. 140-51.

5 **Round-headed appletree borer,** Saperda candida Fabr. Principal food plant: appletree.

Treatment: Dig out borers, protect trunk with paper or wire netting, use carbolic-soap washes.

Chief accessible articles: **Lintner, J. A.,** state ent. 5th rep't, '89. p. 269-71; **Chittenden, F. H.** U. S. dep't agric. div. ent. Circ. 32, 2d s. '98. p. 1-8.

6 **Flat-headed appletree borer,** Chrysobothris femorata Fabr. Principal food plants: apple, pear and plum trees.

Treatment: carbolic-soap washes, digging borers out.

Chief accessible article: **Chittenden, F. H.** U. S. dep't agric. div. ent. Circ. 32, 2d s. '98. p. 9–12.

6a **Peach tree borer,** Sanninoidea exitiosa Say. Principal food plant: peach.

Treatment: Apply washes between June 5 and July 1 or use protective bands and supplement by digging out borers.

Chief accessible articles: **Fitch, Asa.** Noxious and other insects. N. Y. 1st rep't, p. 108-117; **Lintner, J. A.,** state ent. 8th rep't, '91. p. 181-86; **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 176, '99, p. 192.

7 **Pear blight beetle,** Xyleborus dispar Fabr. Principal food plant: peartree.

Treatment: Cut and burn infested limbs, keep trees vigorous.

Chief accessible articles: **Lintner, J. A.,** state ent. 7th rep't, '91. p. 348-51; **Hubbard, H. G.** U. S. dep't agric. div. ent. Bul. 7, n. s. '97. p. 22–23.

8 **Fruit tree bark beetle,** Scolytus rugulosus Ratz. Principal food plants: peach, plum, cherry trees.

Treatment: Cut and burn badly infested limbs, keep trees vigorous.

Chief accessible articles: **Lintner, J. A.,** state ent. 4th rep't, '88. p. 103–7; **Chittenden, F. H.** U. S. dep't agric. div. ent. Circ. 29, 2d s. '98. p. 1–8.

9 **Rose beetle,** Macrodactylus subspinosus Fabr. Principal food plants: fruit trees and rosebushes.

Treatment: Spray beetles with whale oil soap, ½ pound to 1 gallon water, dust plants with plaster, ashes, etc.; hand picking.

Chief accessible articles: **Lintner, J. A.**, state ent. 1st rep't, '82. p. 227–32; **Chittenden, F. H.** U. S. dep't agric. div. ent. Circ. 11, 2d s. '95. p. 1–4; **Marlatt, C. L.** U. S. dep't agric. Yearbook. '95. p. 396–98.

10 **Appletree tent-caterpillar**, Clisiocampa americana Fabr. Principal food plants: wild cherry, appletrees.

Treatment: Collect and destroy egg belts, kill young while in nests, spray with poison in early spring.

Chief accessible articles: **Felt, E. P.**, state ent. 14th rep't (N. Y. state mus. Bul. 23). '98. p. 177–90; N. Y. state mus. Bul. 27. '99. p. 46–48; **Lowe, V. H.** N. Y. agric. exp. sta. Bul. 152. '98. p. 281–93; **Beach, Lowe and Stewart.** N. Y. agric. exp. sta. Bul. 170. '99. p. 389–90; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59: 271–72.

11 Pimpla conquisitor Say, a parasite on the above.

12 **Gipsy moth**, Porthetria dispar Linn. Principal food plants: fruit, oak, maple and other forest trees.

Treatment: Collect and destroy eggs, kill clustered larvae, spray with arsenate of lead.

Chief accessible articles: **Fernald, C. H.** Mass. (Hatch) agric. exp. sta. Special bul. Nov. '89. p. 1–8; **Forbush, E. H., and Fernald, C. H.** Mass. state board agric. Rept's 1892-1900; **Lintner, J. A.**, state ent. 9th rep't, '92. p. 420-26; **Howard, L. O.** U. S. dep't agric. div. ent. Bul. 11, n. s. '97. p. 1-39; **Forbush, E. H.** U. S. dep't agric. div. ent. Bul. 20, n. s. '99. p. 104-7; **Felt, E. P.**, state ent. 16th rep't, '00 (N. Y. state mus. Bul. 36). p. 955-62.

13 **Brown tail moth**, Euproctis chrysorrhoea Linn. Principal food plants: pear, apple, quince.

Treatment: Cut and burn winter nests, spray trees with poison.

Chief accessible articles: **Fernald, C. H., and Kirkland, A. H.** Mass. (Hatch) agric. exp. sta. Special bul. July '97. p. 1-15; U. S. dep't agric. div. ent. Bul. 17, n. s. '98. p. 24-32.

14 **Palmer worm,** Ypsolophus pometellus Harris. Principal food plant: appletree.

Treatment: Spray with poison in early June.

Chief accessible articles: **Fitch, Asa.** Noxious, and beneficial insects N. Y. 1st–2d rep'ts, '56. p. 221–33; **Lowe, V. H.** Rural New Yorker, July 14, '00. 59: 477–78; **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 187. '00. p. 81–101; **Felt, E. P.**, state ent. 16th rep't, '00. p. 962–66.

15 **Oblique banded leaf-roller,** Cacoecia rosaceana Harris. Principal food plant: appletree.

Treatment: Spray early with poison.

Chief accessible notice: **Lintner, J. A.**, state ent. 12th rep't, '96. p. 312.

16 **Apple leaf-folder,** Phoxopteris nubeculana Clem. Principal food plant: appletree.

Treatment: Burn infested leaves.

Chief accessible article: **Riley, C. V.** U. S. dep't agric. Rep't, '78. p. 34–35.

17 **Pistol case-bearer,** Coleophora malivorella Riley. Principal food plant: appletree.

Treatment: Spray thoroughly with poison in early spring.

Chief accessible articles: **Riley, C. V.** U. S. dep't agric. Rep't, '78. p. 48–49; **Lintner, J. A.**, state ent. 1st rep't, '82. p. 163–67; **Lowe, V. H.** N. Y. state agric. soc. Trans. '96. p. 352–61; **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 124. '97. p. 1–16; **Hall, F. H.** N. Y. agric. exp. sta. Bul. 122. '97. p. 1–5; **Lowe, V. H.** N. Y. agric. exp. sta. Bul. 122. '97. p. 221–31.

18 **Cigar case-bearer,** Coleophora fletcherella Fern. Principal food plants: apple.

Treatment: Spray thoroughly with poison in early spring.

Chief accessible articles: **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 93. '95. p. 214–30; **Beach, Lowe** and **Stewart,** N. Y. agric. exp. sta. Bul. 170. '99. p. 391–92.

19 **Apple leaf-miner,** Tischeria malifoliella Clem. Principal food plant: appletree.

Treatment: Burn infested leaves.

Chief accessible article: **Lintner, J. A.**, state ent. 11th rep't, '95. p. 160–62.

20 **Resplendent shield-bearer,** Aspidisca splendoriferella Clem. Principal food plant: appletree.

Treatment: Spray in winter or early spring with contact insecticides.

Chief accessible article: **Comstock, J. H.** U. S. dep't agric. Rep't, '79. p. 210-13.

21 **Apple leaf Bucculatrix,** Bucculatrix pomifoliella Clem. Principal food plant: appletree.

Treatment: Spray with poison in early June.

Chief accessible article: **Lintner, J. A.**, state ent. 1st rep't, '82. p. 157-62.

22 **Bud moth,** Tmetocera ocellana Schiff. Principal food plant: appletree.

Treatment: Spray with poison in early spring.

Chief accessible articles: **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 50. '93. p. 1-29; ——— ——— Bul. 107. '96. p. 57-66; **Lowe, V. H.** N. Y. agric. exp. sta. Bul. 136. '97: p. 397-98.

23 **Pear psylla,** Psylla pyricola Forst. Principal food plant: pear tree.

Treatment: Spray with kerosene emulsion in early spring.

Chief accessible articles: **Lintner, J. A.**, state ent. 9th rep't, '92. p. 317-29; **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 44. '92. p. 161-86; ——— ——— Bul. 108. '96. p. 69-81; **Marlatt, C. L.** U. S. dep't agric. div. ent. Circ. 7, 2d s. '95. p. 1-8.

VINE AND SMALL FRUIT INSECTS (24-41)

For general works, *see* those cited under fruit tree insects.

24 **Grapevine root worm,** Fidia viticida Walsh. Principal food plant: grapevine.

Treatment: Spray with poison the latter part of June; keep soil pulverized and mounded about the base of vines in July.

Chief accessible articles: **Webster, F. M.** O. agric. exp. sta. Bul. 62. '95 p. 77-95; **Marlatt, C. L.** U. S. dep't agric. Yearbook. '95. p. 391-93; **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 184. '00. p. 21-32.

25 **Spotted grapevine beetle,** Pelidnota punctata Linn. Principal food plant: grapevine.

Treatment: hand picking.

Chief accessible notice: **Felt, E. P.** N. Y. state mus. Bul. 37. '00. p. 15.

26 **Light-loving grapevine beetle,** Anómala lucicola Fabr. Principal food plant: grapevine.

Treatment: hand picking, dusting vines with ashes, plaster, etc.

Chief accessible article: **Lintner, J. A.,** state ent. 10th rep't '94. p. 408-10.

27 **Grapevine flea beetle,** Haltica chalybea Ill. Principal food plant: grapevine.

Treatment: Spray vines with poison.

Chief accessible articles: **Comstock, J. H.** U. S. dep't agric. rep't, '79. p. 213–16; **Marlatt, C. L.** U. S. dep't agric. Yearbook. '95. p. 395–96; **Lowe, V. H.** N. Y. agric. exp. sta. Bul. 150. '98. p. 263–65; **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 157. '98. p. 189–213.

28 **8 spotted forester,** Alypia octomaculata Fabr. Principal food plants: Virginia creeper, grapevine.

Treatment: Spray with arsenical poisons.

Chief accessible article: **Lintner, J. A.,** state ent. 5th rep't, '89. p. 179-83.

29 **Grapevine plume moth,** Oxyptilus periscelidactylus Fitch. Principal food plant: grapevine.

Treatment: hand picking; spray with poison.

Chief accessible articles: **Fitch, Asa.** Noxious, beneficial insects N. Y. 1st-2d rep'ts, '56. p. 139-43; **Lintner, J. A.,** state ent. 12th rep't, '96. p. 218-22.

30 **Grapevine leaf-hopper,** Typhlocyba comes Say. Principal food plant: grapevine.

Treatment: Burn rubbish in fall or spring, early spray with kerosene emulsion.

Chief accessible article: **Marlatt, C. L.** U. S. dep't agric. Yearbook. '95. p. 400-2.

31 **Currant stem-borer,** Sesia tipuliformis Linn. Principal food plant: currant.

Treatment: Cut and burn infested stems.

32 **Red-breasted currant borer,** Tenthredo rufopectus Nort. Principal food plant: currant.

Treatment: Cut and burn wilting tips.

Chief accessible article: **Lintner, J. A.,** state ent. 13th rep't, '97. p. 335-37.

33 **Currant sawfly,** Pteronus ribesii Scop. Principal food plant: currant.

Treatment: Spray foliage with hellebore or an arsenical poison.

Chief accessible articles: **Fitch, Asa.** Noxious, beneficial insects N. Y. 12th rep't, '67. p. 909-32; **Lintner, J. A.,** state ent. 2d rep't, '85. p. 217-21.

34 **Currant spanworm,** Diastictis ribearia Fitch. Principal food plant: currant.

Treatment: Spray foliage with an arsenical poison.

Chief accessible notices: **Lintner, J. A.,** state ent. 12th rep't, '96. p. 310-11; **Felt, E. P.** N. Y. state mus. Bul. 37. '00. p. 13-14.

35 **Tarnished plant bug,** Lygus pratensis Linn. Principal food plant: peachtree.

Treatment: hand picking, dusting with ashes, clean culture.

Chief accessible article: **Lintner, J. A.,** state ent. 13th rep't, '97. p. 351-57.

36 **4 lined leaf bug,** Poecilocapsus lineatus Fabr. Principal food plant: currant.

Treatment: Spray young with kerosene emulsion, cut and burn egg-bearing twigs.

Chief accessible articles: **Lintner, J. A.,** state ent. 1st rep't, '82. p. 271-81; **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 58. '93. p. 207-39.

37 **Gouty gall beetle,** Agrilus ruficollis Fabr. Principal food plant: raspberry.

Treatment: Cut and burn infested canes in early spring.

Chief accessible articles: **Lintner, J. A.,** state ent. 6th rep't, '90. p. 123-25; ——— 10th rep't, '94. p. 406-7.

38 **White flower cricket,** Oecanthus niveus DeG. Principal injury to raspberry bushes.

Treatment: Cut and burn infested canes in early spring. Clean culture.

39 **Fuller's rose beetle,** Aramigus fulleri Horn. Principal food plant: rosebush.

Treatment: hand picking.

Chief accessible article: **Lintner, J. A.**, state ent. 2d rep't, '85. p. 142–44.

40 Thyreus abbotii Swains. Principal food plants: grapevine, Virginia creeper.

Treatment: hand picking.

Chief accessible article: **Cooley, R. A.** Mass agric. exp. sta. Bul. 36. '96. p. 11–12.

41 **Cranberry worm,** Rhopobota vacciniana Pack. Principal food plant: cranberry.

Treatment: Flow bogs after eggs hatch, spray vines with arsenical poisons.

Chief accessible articles: **Smith, J. B.** N. J. agric. exp. sta. Special bul. K. '90. p. 10–15; **Fernald, C. H.** Mass. (Hatch) exp. sta. Bul. 19. '92. p. 135–37; —— Mass. state board agric. Rep't, '97. p. 145–48.

GARDEN INSECTS (42-68)

For general works, *see* last two publications cited under Fruit tree insects, p. 833.

42 **Wheat wireworm,** Agriotes mancus Say. This insect and its allies may injure a number of garden crops.

Treatment: Fall plowing; use poisoned baits for beetles.

Chief accessible articles: **Comstock, J. H., and Slingerland, M. V.** Cornell agric. exp. sta. Bul. 33. '91. p. 251–58; —— —— Bul. 107. '96. p. 51–52.

43 **Cabbage butterfly,** Pieris rapae Linn. Principal food plant: cabbage.

Treatment: Spray young plants with arsenical poisons, use hellebore or pyrethrum on older ones.

Chief accessible notice: **Felt, E. P.** N. Y. state mus. Bul. 37. '00. p. 29-30.

44 **Zebra caterpillar,** Mamestra picta Harr. Principal food plant: cabbage.

Treatment: Spray young plants with arsenical poisons, use pyrethrum or hellebore on older ones.

Chief accessible articles: **Lintner, J. A.,** state ent. 5th rep't, '89. p. 206-10; **Felt, E. P.,** state ent. 14th rep't, '98. p. 201-7.

45 Microplitis mamestrae, Weed, a parasite of the preceding.

46 **Variegated cutworm,** Peridroma saucia Hübn. Principal food plants: a number of garden crops.

Treatment: poisoned baits.

Chief accessible article: **Lintner, J. A.,** state ent. 5th rep't, '89. p. 200-6.

47 **Colorado potato beetle,** Doryphora 10-lineata Say. Principal food plant: potato.

Treatment: Spray with arsenical poisons, hand picking.

48 Lebia grandis Hentz. This species preys on the preceding.

49 **Spined soldier bug,** Podisus spinosus Dall. Another predaceous enemy of 47.

50 **Margined blister beetle,** Epicauta cinerea Forst. Principal food plant: frequently injures potatoes.

Treatment: Dust vines with ashes, plaster, etc., spray with arsenical poisons only when necessary, as the young are beneficial.

Chief accessible article: **Lintner, J. A.,** state ent. 6th rep't, '90. p. 134-35.

51 **Striped blister beetle,** Epicauta vittata Fabr. Principal food plant: frequently injures potatoes.

Treatment: Same as preceding.

Chief accessible article: **Lintner, J. A.,** state ent. 6th rep't, '90. p. 132-34.

52 **Stalk-borer,** Hydroecia nitela Guen. Principal food plants: tomato, potato and other thick stalked plants.

Treatment: Destroy caterpillars in wilting stalks.

Chief accessible article: **Lintner, J. A.,** state ent. 1st rep't, '82. p. 110-16.

53 **Tomato worm,** Phlegethontius celeus Hübn. Principal food plant: tomato.

Treatment: Spray with arsenical poisons before fruit appears, hand picking.

Chief accessible article: **Howard, L. O.** U. S. dep't agric. Yearbook. '98. p. 128-32.

54 **Striped cucumber beetle,** Diabrotica vittata Fabr. Principal food plant: cucumber vines.

Treatment: Spray vines with poisoned bordeaux mixture, dust vines with ashes, plaster, etc.

Chief accessible articles: **Chittenden, F. H.** U. S. dep't agric. div. ent. Circ. 31, 2d s. '98. p. 1–7; **Sirrine, F. A.** N. Y. agric. exp. sta. Bul. 158. '99. p. 1-32.

55 **Squash vine borer,** Melittia satyriniformis Hübn. Principal food plant: squash vines.

Treatment: Plant early squashes as a trap crop, cut out and destroy borers.

Chief accessible article: **Lintner, J. A.,** state ent. 2d rep't, '85. p. 57–68; **Sirrine, F. A.** N. Y. agric. exp. sta. 15th rep't, '96. p. 610-12; **Chittenden, F. H.** U. S. dep't agric. div. ent. Circ. 38, 2d s. '99. p. 1–6; —— —— Bul. 19, n. s. '99. p. 34–40.

56 **Cucumber flea beetle,** Epitrix cucumeris Harris. Principal food plants: cucumbers, potatoes, tomatoes.

Treatment: Spray plants with poisoned bordeaux mixture, dust with ashes, plaster, etc.

Chief accessible article: **Stewart, F. C.** N. Y. agric. exp. sta. Bul. 113. '96. p. 311-17.

57 **Red-headed flea beetle,** Systena frontalis Fabr. Principal injury recorded was to sugar beets.

Treatment: Spray plants with arsenical poisons, the poisoned bordeaux mixture being specially effective.

Chief accessible notice: **Felt, E. P.,** state ent. 15th rep't, '00. p. 538.

58 **Common asparagus beetle,** Crioceris asparagi Linn. Principal food plant: asparagus.

Treatment: spray all except cutting beds with an arsenical poison, dust plants with plaster, ashes, etc.

Chief accessible articles: **Lintner, J. A.**, state ent. 1st rep't, '82. p. 239–46; —— 11th rep't, 95. p. 177–81; **Chittenden, F. H.** U. S. dep't agric. Yearbook. '96. p. 342-49; **Felt, E. P.**, state ent. 15th rep't, '00. p. 540-41.

59 **12 spotted asparagus beetle,** Crioceris 12-punctata Linn. Principal food plant: asparagus.

Treatment: same as for the preceding species.

Chief accessible articles: **Lintner, J. A.**, state ent. 12th rep't, '96. p. 248-52; **Chittenden, F. H.** U. S. dep't agric. Yearbook. '96. p. 349-52; **Felt, E. P.**, state ent. 15th rep't, '00. p. 540-41.

60 **Squash bug,** Anasa tristis DeG. Principal food plant: squash vine.

Treatment: Trap under chips and destroy the bugs, collect and destroy the eggs.

Chief accessible articles: **Chittenden, F. H.** U. S. dep't agric. div. ent. Bul. 19, n. s. '99. p. 20-28; —— —— Circ. 39, 2d s. '99. p. 1-5.

61 **Onion thrips,** Thrips tabaci Lind. Principal food plants: onion, lettuce.

Treatment: Spray affected plants with kerosene emulsion or whale oil soap solution.

Chief accessible article: **Lintner, J. A.**, state ent. 11th rep't, '95. p. 241-47.

62 **Rhubarb curculio,** Lixus concavus Say. Principal food plant: rhubarb.

Treatment: hand picking.

Chief accessible article: **Chittenden, F. H.** U. S. dep't agric. div. ent. Bul. 23, n. s. '00. p. 61-69.

63 **Chrysanthemum fly,** Phytomyza chrysanthemi Kow. Principal food plant: chrysanthemum.

Treatment: Destroy infested leaves.

Chief accessible articles: **Lintner, J. A.**, state ent. 4th rep't, '88. p. 73-80; —— 7th rep't, '91. p. 242-46.

64 **Mushroom phora,** Phora agarici Lintn. Principal food plant: mushrooms.

Treatment: Kill flies with dry pyrethrum.

Chief accessible article: **Lintner, J. A.**, state ent. 10th rep't, '94. p. 399-405.

65 **Manure fly**, Sciara coprophila Lintn. Principal food: decaying vegetable matter, rarely injurious.

Treatment: Spray soil with kerosene emulsion and follow with a sprinkling of water.

Chief accessible articles: **Lintner, J. A.**, state ent. 10th rep't, '94. p. 391-97.

66 **Wild parsnip worm**, Depressaria heracliana DeG. Principal food plant: wild parsnip, and the species therefore can hardly be considered injurious.

67 **Genista caterpillar**, Mecyna reversalis Guen. Principal food plant: Genista and Cytisus.

Treatment: Spray infested plants with hellebore or an arsenical poison.

Chief accessible article: **Lintner, J. A.**, state ent. 11th rep't, '95. p. 142-45.

68 **Milkweed butterfly**, Anosia plexippus Linn. Principal food plant: common milkweed. This is a common but not an injurious species.

GRASS AND GRAIN INSECTS (69-83)

For general works, *see* last two publications cited under Fruit tree insects, p. 833.

69 **May beetle**, Lachnosterna fusca Frohl. Principal food plant: grass roots.

Treatment: Spray infested areas heavily with kerosene emulsion just before a rain or follow spraying with a liberal watering.

Chief accessible article: **Lintner, J. A.**, state ent. 9th rep't, '92. p. 353-57.

70 **Green June beetle**, Allorhina nitida Linn. Principal food plant: decomposing vegetable matter and possibly grass roots to some extent.

Treatment: same as for the preceding, also poisoned bran mash.

Chief accessible article: **Howard, L. O.** U. S. dep't agric. div. ent. Bul. 10, n. s. '98. p. 20-26.

71 **Punctured clover leaf weevil,** Phytonomus punctatus Fabr. Principal food plant: clover.

Treatment: Plow under badly infested fields.

Chief accessible articles: **Lintner, J. A.,** state ent. 1st rep't, '82 p. 247-53; —— 5th rep't, '89. p. 272-73; —— 7th rep't, '91. p. 315-16.

72 Phytonomus nigrirostris Fabr. Principal food plant: clover; it is not a species of much economic importance.

73 **Army worm,** Leucania unipuncta Haw. Principal food plants: grass and grains.

Treatment: clean culture, debarring from infested fields, poisoned bran mash.

Chief accessible articles: **Lintner, J. A.,** state ent. 11th rep't, '96. p. 190-214; **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 133. '97. p. 233-58; **Lowe, V. H.** N. Y. agric. exp. sta. Bul. 104. '96. p. 122-29; —— 15th rep't, '96. p. 583-605.

74 **Clover hay caterpillar,** Pyralis costalis Fabr. Principal food plant: clover.

Treatment: Keep hay clean and dry, salt lower layers, do not allow old hay to remain over from year to year.

Chief accessible article: **Lintner, J. A.,** state ent. 11th rep't, '95. p. 145-51.

75 **Hessian fly,** Cecidomyia destructor Say. Chief food plant: wheat.

Treatment: Late planting in connection with early sown decoy strips to be plowed under in late fall; grow resistant varieties, cut straw high in infested districts and burn stubble.

Chief accessible articles: **Fitch, Asa.** Noxious, beneficial insects N. Y. 7th rep't, '62. p. 133-44; **Marlatt, C. L.** U. S. dep't agric. div. ent. Circ. 14, 2d s. '95. p. 1-4; **Osborn, Herbert.** U. S. dep't agric. div. ent. Bul. 16, n. s. '98. p. 1-57.

76 **Jointworm,** Isosoma hordei Harr. Principal food plant: barley.

Treatment: Burn infested straw.

Chief accessible articles: **Fitch, Asa.** Noxious, beneficial insects N. Y. 7th rep't, '62. p. 155-59; **Lintner, J. A.,** state ent. 4th rep't, '88. p. 27-35.

77 **Isosoma grande** Riley. Principal food plant: wheat.

Treatment: same as preceding.

Chief accessible articles: **Riley, C. V.** U. S. dep't agric. Rep't, '84. p. 357-58; **Webster, F. M.** U. S. dep't agric. Rep't, '84. p. 383-87; ——— ———, Rep't, '85. p. 311-15; **Riley, C. V.** U. S. dep't agric. Rep't, '86. p. 542-46.

78 **Chinch bug,** Blissus leucopterus Say. Principal food plants: grasses, small grains, corn.

Treatment: Burn grass, etc. sheltering hibernating bugs, sow decoy plots, plow badly infested areas or spray with kerosene emulsion, protect cultivated crops by barriers.

Chief accessible articles: **Lintner, J. A.**, state ent. 2d rep't, '85. p. 148-64; **Webster, F. M.** U. S. dep't agric. div. ent. Bul. 15, n. s. '98. p. 1-82.

79 **Red-legged locust,** Melanoplus femur-rubrum DeG. Principal food plants: grasses and grains.

Treatment: Plow young hoppers under, collect with hopper-dozer; poisoned bran mash.

Chief accessible article: **Lintner, J. A.**, state ent. 10th rep't, '94. p. 439-45.

80 Melanoplus femoratus Burm. Same as 79.

81 **Pellucid locust,** Camnula pellucida Scudd. Same as 79.

82 **Carolina locust,** Dissosteira carolina Linn. Same as 79.

83 Circotettix verruculatus Scudd. Same as 79.

HOUSEHOLD INSECTS (84-99)

84 **Little red ant,** Monomorium pharaonis Linn. Principal food: sweets, lard, etc.

Treatment: Destroy nests with carbon bisulfid, kerosene emulsion or boiling water, trap with lard or sponge dipped in sweetened water and destroy.

Chief accessible articles: **Marlatt, C. L.** U. S. dep't agric. div. ent. Bul. 4, n. s. '96. p. 95-99; ——— ——— Circ. 34, 2d s. '98. p. 1-4; **Lintner, J. A.**, state ent. 11th rep't, '95. p. 109-14; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59:298-99.

85 **Large black ant**, Camponotus pennsylvanica Cress. Bores in wood and is occasionally found in houses.

Treatment: same as for 84, so far as practicable.

86 **House fly**, Musca domestica Linn. Principal food: a very general feeder.

Treatment: keep premises clean and prevent the flies from getting at manure. Exclude with screens.

Chief accessible articles: **Howard, L. O.**, and **Marlatt, C. L.** U. S. dep't. agric. div. ent. Bul. 4, n. s. '96 p. 43-47; **Howard, L. O.** U. S. dep't agric. div. ent. Circ. 35, 2d s. '98. p. 1-8; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59:295-96.

87 **Cheese skipper**, Piophila casei Linn. Principal food: cheese, ham.

Treatment: Exclude flies, keep affected products in darkness, destroy eggs every few days.

Chief accessible articles: **Howard, L. O.** U. S. dep't agric. div. ent. Bul. 4, n. s. '96. p. 102-4; **Lintner, J. A.**, state ent. 12th rep't, '96. p. 229-34; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59:300-1.

88 **Larder beetle**, Dermestes lardarius Linn. Principal food: bacon, dried meat, skins, etc.

Treatment: Keep the beetles away by using screens or tight receptacles, clean up frequently, and give the pest little opportunity to breed.

Chief accessible articles: **Lintner, J. A.**, state ent. 6th rep't, '90. p. 119-23; **Howard, L. O.** U. S. dep't agric. div. ent. Bul. 4, n. s. '96. p. 107-9; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59: 300.

89 **Croton bug**, Phyllodromia germanica Fabr. Principal food: a very general feeder.

Treatment: Cleanliness and the use of a roach poison, such as Hooper's fatal food; fumigate with sulfur, entice the insects to enter vessels partly filled with stale beer, from which no escape is provided.

Chief accessible articles: **Marlatt, C. L.** U. S. dep't agric. div. ent. Bul. 4, n. s. '96. p. 90-95; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59: 229.

90 **Cockroach,** Periplaneta orientalis Linn. Principal food: a very general feeder.

Treatment: same as for 89.

Chief accessible articles: **Marlatt, C. L.** U. S. dep't. agric. div. ent. Bul. 4, n. s. '96. p. 90-95; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59: 299.

91 **Black carpet beetle,** Attagenus piceus Oliv. Principal food: woolens, horn, dried animal matter.

Treatment: Use rugs or matting in place of carpet whenever possible. Infested carpets should be taken up and sprayed with benzin, and the cracks in the floor should be filled with plaster before relaying. Clean garments and furs thoroughly and store during the summer in tight boxes. Fumigate infested apartments with sulfur.

Chief accessible articles: **Lintner, J. A.,** state ent. 2d rep't, '85. p. 46-48; —— 9th rep't, '92. p. 299-306; **Howard, L. O.,** and **Marlatt, C. L.** U. S. dep't agric. div. ent. Bul. 4, n. s. '96. p. 61-63; **Chittenden, F. H.** U. S. dep't agric. div. ent. Bul. 8, n. s. '97. p. 15-19; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59: 297-98.

92 **Buffalo carpet beetle,** Anthrenus scrophulariae Linn. Principal food: woolens, dried animal matter.

Treatment: same as for 91.

Chief accessible articles: **Lintner, J. A.,** state ent. 9th rep't, '92. p. 299-306; **Howard, L. O.,** and **Marlatt, C. L.** U. S. dep't agric. div. ent. Bul. 4, n. s. '96. p. 58-60; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59: 297-98.

93 **Two spotted ladybug,** Adalia bipunctata Linn. Food: Preys on other insects and is therefore beneficial, though it is frequently mistaken for a carpet beetle.

Treatment: Always protect the beetles.

Chief accessible articles: **Lintner, J. A.,** state ent. 9th rep't, '92. p. 300; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59: 297.

94 **Museum pest,** Anthrenus verbasci Linn. Principal food: dried animal matter.

Treatment: Exclude from collections by using tight boxes, and supplement by frequent examinations, fumigate infested boxes with carbon bisulfid.

Chief accessible article: **Chittenden, F. H.** U. S. dep't agric. div. ent. Bul. 8, n. s. '97. p. 22-23.

95 **Clothes moth,** Tineola biselliella Hum. Principal food: woolens.

Treatment: same as for 91.

Chief accessible articles: **Marlatt, C. L.** U. S. dep't agric div. ent. Circ. 36, 2d s. '98. p. 1-8; **Howard, L. O.,** and **Marlatt, C. L.** U. S. dep't agric. div. ent. Bul. 4, n. s. '96. p. 63-69; **Felt, E. P.** N. Y. state agric soc. Trans. '99. 59: 297-98.

96 **Silver fish,** Thermobia furnorum Rov. Principal food: farinaceous matter.

Treatment: Keep things dry and do not allow them to remain undisturbed for long periods, dust haunts with pyrethrum powder.

Chief accessible articles: **Marlatt, C. L.** U. S. dep't agric. div. ent. Bul. 4, n. s. '96. p. 76-78; **Felt, E. P.,** state ent. 14th rep't, '98. p. 216-18; —— N. Y. state agric. soc. Trans. '99. 59: 301.

97 **Bedbug,** Acanthia lectularia Linn. Principal food: blood of certain mammalia.

Treatment: Apply benzin, kerosene, other petroleum oil or corrosive sublimate to crevices in infested beds. Fumigation with sulfur is valuable wherever possible.

Chief accessible articles: **Marlatt, C. L.** U. S. dep't agric. div. ent. Bul. 4, n. s. '96. p. 32-38; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59: 299-300.

98 **Masked bedbug hunter: kissing bug,** Opsicoetus personatus Linn. Principal food: other insects; only occasionally does it attack man.

Treatment: Exclude from houses by the use of screens.

Chief accessible articles: **Howard, L. O.** Popular science monthly, Nov. '99; —— U. S. dep't agric. div. ent. Bul. 22. '00. p. 24-25.

99 **Squash bug,** Anasa tristis DeG. Resembles 98 somewhat, but on comparison a marked difference will be seen.

INSECTS AFFECTING STORED FOOD PRODUCTS (100-8)

100 **Rice weevil,** Calandra oryzae Linn. Principal food: rice or its preparations.

Treatment: Fumigate with carbon bisulfid.

Chief accessible article: **Chittenden, F. H.** U. S. dep't agric. Yearbook. '94. p. 280-81.

101 Pteromalus calandrae How., a parasite of 100.

102 **Grain moth,** Sitotroga cerealella Oliv. Principal food: corn, wheat.

Treatment: Harvest and thresh grain early, fumigate infested grain with carbon bisulfid.

Chief accessible articles: **Lintner, J. A.**, state ent. 2d rep't, '85. p. 102-10; ——— 10th rep't, '94. p. 377-86; **Chittenden, F. H.** U. S. dep't agric. Yearbook. '94. p. 281-83.

103 **Corn Silvanus,** Silvanus surinamensis Linn. Principal food: cereal grains.

Treatment: Fumigate infested materials with carbon bisulfid.

Chief accessible articles: **Chittenden, F. H.** U. S. dep't agric. Yearbook. '94. p. 287.

104 **Meal worm,** Tenebrio molitor Linn. Principal food: corn and rye meal.

Treatment: Fumigate infested meal with carbon bisulfid.

Chief accessible articles: **Lintner, J. A.**, state ent. 8th rep't, '91. p. 176-77; **Chittenden, F. H.** U. S. dep't agric. div. ent. Bul. 4, n. s. '96. p. 116-17.

105 **Bean weevil,** Bruchus obtectus Say. Principal food: beans.

Treatment: Fumigate infested seeds with carbon bisulfid.

Chief accessible article: **Lintner, J. A.**, state ent. 7th rep't, '91. p. 255-79.

106 **Pea weevil,** Bruchus pisorum Linn. Principal food: pea.

Treatment: Early planting; fumigate infested peas with carbon bisulfid.

Chief accessible article: **Riley, C. V.**, and **Howard, L. O.** Insect life. '91. 4: 297-99.

107 **Confused flour beetle,** Tribolium confusum Duv. Principal food: Farinaceous preparations.

Treatment: Fumigate infested preparations with carbon bisulfid.

Chief accessible articles: **Chittenden, F. H.** U. S. dep't agric. Yearbook. '94. p. 288-89; —— —— div. ent. Bul. 4. '96. p. 113-15.

108 **Cigarette beetle,** Lasioderma testaceum Duft. Principal food: tobacco preparations.

Treatment: Fumigate infested substances with carbon bisulfid, exclude the insects by using tight packages.

Chief accessible article: **Chittenden, F. H.** U. S. dep't agric. div. ent. Bul. 4. n. s. '96. p. 126-27.

BENEFICIAL INSECTS (109-63)

Pollen-carriers

These insects perform a most important function, because many fruit trees depend very largely on insects for the carrying of pollen from flower to flower.

109 **Honey bee,** Apis mellifica Linn. This insect is exceedingly valuable as a pollenizer of plants as well as a producer of honey.

Bumblebees, Bombus

This genus is represented by a number of species, all valuable as pollen-carriers.

110 Bombus fervidus Fabr.

111 B. pennsylvanicus DeG.

112 B. terricola Kirby

113 B. ternarius Say

114 B. vagans Smith

115 B. virginicus Oliv.

116 Melissodes obliqua Say

117 M. perplexa Cress.

Leaf-cutter bees, Megachile

The popular name comes from the peculiar habit certain species, at least, have of cutting bits out of leaves to use in nest building.

118 Megachile montivaga Cress.
119 M. latimanus Say
120 Andrena crataegi Rob.
121 A. fimbriata Smith
122 Agapostemon radiatus Say
123 Halictus parallelus Say
124 **Wasp,** Polistes pallipes St Farg.
125 Vespa arenaria Fabr.
126 **Yellow jacket,** Vespa diabolica Sauss.
127 **White-faced hornet,** Vespa maculata Linn.

Flower flies; syrphus flies, Syrphidae

128 Spilomyia fusca Loew
129 Helophilus latifrons Loew
130 H. similis Macq.
131 Eristalis flavipes Walk.
132 E. tenax Linn.
132a Tropidopria conica Fabr., a parasite of the above.
133 Eristalis transversus Wied.
134 Volucella evecta Walk.

Parasites

A number of serious insect pests are held in check by parasitic enemies. These beneficial species should be protected, and in fighting insects the destruction of parasites should be avoided whenever possible.

135 Pteromalus vanessae How.
136 Pimpla conquisitor Say
137 Ophion purgatum Say
138 Ichneumon flavicornis Cr.
139 **Red-tailed tachina fly,** Winthemia 4-pustulata Fabr.

Predaceous insects

Some predaceous insects are most efficient aids in controlling insect depredations. The syrphid flies and ladybugs are examples of well known enemies of plant lice.

140 **Potter wasp,** Eumenes fraternus Say

141 **Digger wasp,** Bembex fasciata Fabr.

142 Sphaerophoria cylindrica Say

143 Syrphus ribesii Linn.

144 **Margined soldier beetle,** Chauliognathus marginatus Fabr.

145 **Pennsylvania soldier beetle,** Chauliognathus pennsylvanicus DeG.

Ladybugs, Coccinellidae

Plant lice or aphids find some of their most serious enemies in this group.

146 Brachyacantha ursina Fabr.

147 **Twice-stabbed ladybug,** Chilocorus bivulnerus Muls.

148 **15 spotted ladybug,** Anatis ocellata Linn.

149 **Two spotted ladybug,** Adalia bipunctata Linn.

150 Coccinella sanguinea Linn.

151 **Transverse ladybug,** Coccinella transversalis Muls.

152 **Nine spotted ladybug,** Coccinella 9-notata Herbst.

153 **Three banded ladybug,** Coccinella trifasciata Linn.

154 **Parenthetical ladybug,** Hippodamia parenthesis Say

155 **Convergent ladybug,** Hippodamia convergens Guer.

156 **Spotted ladybug,** Megilla maculata DeG.

157 **Spined soldier bug,** Podisus spinosus Dall.

158 **Lace-winged fly,** Chrysopa species.

Silkworms

The mulberry silkworm is the insect which produces all the raw material from which silks are manufactured. Several related species are also represented in the collection.

159 **Mulberry silkworm,** Bombyx mori Linn.

160 **Cynthia moth,** Samia cynthia Dru.

161 **Polyphemus moth: American silkworm,** Telea polyphemus Cram.

162 **Japanese silkworm,** Antheraea yamimai Guer.

163 **Chinese silkworm,** Antheraea pernyi Guer.

SCALE INSECTS, Coccidae (164-202)

A natural group of great economic importance.

Chief articles on the group

Comstock, J. H. U. S. dep't agric. Rep't, '80. p. 276-349; Cornell univ. dep't ent. 2d rep't, '83. p. 45-147.

Cockerell, T. D. A. Check list of the Coccidae. Ill. state lab. nat. hist. Bul. '96, v. 4, art. 11, p. 318-39; supplement, Ill. state lab. nat. hist. Bul. '99. v. 5, art. 7, p. 389-98.

164 **Cottony cushion scale insect,** Icerya purchasi Mask. This species is of interest on account of its threatening the destruction of the citrus fruit industry of California about 1880. Principal food plants: citrus trees.

Treatment: Importation of natural enemies, fumigation with hydrocyanic acid gas.

Chief articles: **Riley, C. V.** U. S. dep't agric. Rep't, '86. p. 466-91.

165 **Elm tree bark louse,** Gossyparia ulmi Geoff. Principal food plant: European elms.

Treatment: Spray with kerosene emulsion or a whale oil soap solution in early spring.

Chief accessible articles: **Lintner, J. A.,** state ent. 12th rep't, '96. p. 292-97; **Felt, E. P.** N. Y. state mus. Bul. 20. '98. p. 16-18; —— —— Bul. 27. '99. p. 46; —— Fisheries, game and forest com. 5th rep't, '99. p. 375-79.

166 **Oak kermes,** Kermes galliformis Riley. Principal food plant: oaks; rarely injurious.

167 **Golden oak scale insect,** Asterolecanium variolosum Ratz. Principal food plant: oak.

Treatment: Spray with kerosene emulsion in early summer.

Chief accessible articles: **Lowe, V. H.** N. Y. agric. exp. sta. Rep't, '95. p. 550-51.

168 **Barnacle scale insect,** Ceroplastes cirripediformis Comst. A southern species which occurs on orange and quince.

169 **Lecanium armeniacum** Craw. A species recently introduced into New York state.

Principal food plants: grape, currant.

Chief accessible notice: **Felt, E. P.,** state ent. 14th rep't, '98. p. 240.

170 **Cherry lecanium,** Lecanium cerasifex Fitch. Occurs rather commonly on maple, oak, cherry and appletrees.

Treatment: Spray infested trees in winter or in early spring with kerosene emulsion (1-4).

171 Lecanium fitchii Sign. Infests raspberry and blackberry bushes.

172 **Common greenhouse lecanium,** Lecanium hesperidum Linn. A bad pest on many house and greenhouse plants.

Treatment: Spray or wash plants with kerosene emulsion or a soap solution.

173 **Black scale insect,** Lecanium oleae Bern. A serious pest on many plants in California.

174 **New York plum scale insect,** Lecanium prunastri Fonsc. Principal food plant: plum.

Treatment: Spray infested trees with kerosene emulsion (1-4) just after the leaves fall.

Chief accessible articles: **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 83. '94. p. 681-99; —— —— Bul. 108. '96. p. 82-86; **Lowe, V. H.** N. Y. agric. exp. sta. Bul. 136. '97. p. 583-86.

175 **Tuliptree scale insect,** Lecanium tulipiferae Cook. Principal food plant: tuliptree.

Treatment: Spray infested trees with kerosene emulsion or whale oil soap solution.

Chief accessible article: **Felt, E. P.**, state ent. 14th rep't, '98. (Mus. bul. 23) p. 213-16.

176 **Cottony maple tree scale insect,** Pulvinaria innumerabilis Rathv. Principal food plants: maple, elm, grape.

Treatment: Spray young in July with kerosene emulsion or whale oil soap solution. A powerful stream of cold water or a stiff brush will dislodge many females.

Chief accessible articles: **Lintner, J. A.**, state ent. 6th rep't, '90. p. 141-47; **Felt, E. P.** Fisheries, game and forest com. 4th rep't, sep. '98. p. 29-31; **Howard, L. O.** U. S. dep't agric. div. ent. Bul. 22, n. s. '00. p. 8-16.

177 **Putnam's scale insect,** Aspidiotus ancylus Putn. Principal food plants: maple, elm, currant, fruit trees.

Treatment: rarely injurious.

Chief accessible articles: **Lowe, V. H.** N. Y. agric. exp. sta. Bul. 136. '97. p. 593; **Felt, E. P.** N. Y. state mus. Bul. 46. '01. p. 326-30.

178 Aspidiotus dictyospermi Morg. A greenhouse species occurring on Areca lutescens.

179 **Cherry scale insect,** Aspidiotus forbesi Johns. Principal food plants: cherry and apple trees.

Treatment: Spray infested trees in winter or early spring with a contact insecticide.

Chief accessible article: **Felt, E. P.** N. Y. state mus. Bul. 46. '01. p. 330-32.

180 **Ivy scale insect,** Aspidiotus hederae Vall. Principal food plants: common on ivy and a number of other greenhouse plants.

Treatment: Spray infested plants with an ivory or whale oil soap solution.

Chief accessible articles: **Lintner, J. A.**, state ent. 11th rep't, '96. p. 203-4; **Felt, E. P.** N. Y. state mus. Bul. 46. '01. p. 333-36.

181 Aspidiotus lataniae Sign. A greenhouse species infesting palms.

182 **European fruit tree scale insect,** Aspidiotus ostreaeformis Curt. Principal food plant: plum.

Treatment: Spray infested trees in winter or early spring with contact insecticides.

Chief accessible article: **Felt, E. P.** N. Y. state mus. Bul. 46. '01. p. 323-26.

183 **San José scale insect,** Aspidiotus perniciosus Comst. Principal food plants: fruit and many other trees and shrubs.

Treatment: Spray infested trees in winter or early spring with whale oil soap or a mechanical emulsion of crude petroleum.

Chief accessible articles: **Lintner, J. A.,** state ent. 11th rep't, '96. p. 200-33; **Howard, L. O.,** and **Marlatt, C. L.** U. S. dep't agric. div. ent. Bul. 4, n. s. '96. p. 1-80; **Lowe, V. H.** N. Y. agric. exp. sta. Bul. 136. '97. p. 571-602; **Howard, L. O.,** U. S. dep't agric. div. ent. Bul. 12, n.s. '98. p. 1, 1-32; **Felt, E. P.,** state ent. 16th rep't, '00. p. 967-88; —— N. Y. state mus. Bul. 46. '01. p. 304-23, 336-42.

184 **Gloomy scale insect,** Aspidiotus tenebricosus Comst. A southern species infesting red maple.

185 **Elm Aspidiotus,** Aspidiotus ulmi Johns. Principal food plant: elm, rarely injurious.

186 **Grapevine Aspidiotus,** Aspidiotus uvae Comst. A southern species infesting grapvines.

187 **Red scale insect of Florida,** Chrysomphalus aonidum Linn. Principal food plants: on palms and other greenhouse plants.

Treatment: Wash or spray infested plants with whale oil or other soap solution.

188 Xerophilaspis prosopidis Ckll. A southern species occurring on Prosopis velutina.

189 **Cactus scale insect,** Diaspis calyptroides Costa. Found on cactuses in greenhouses.

190 **Juniper scale insect,** Diaspis carueli Targ. Found occasionally on juniper in New York state.

191 **Peach scale insect,** Diaspis pentagona Targ. A dangerous subtropic species which has become established in localities in the southern United States.

192 Aulacaspis boisduvalii Sign. Found on a greenhouse orchid.

193 Aulacaspis elegans Leon. A greenhouse species infesting Cycas revoluta, frequently called sago palm.

194 **Rose scale insect,** Aulacaspis rosae Sandb. Principal food plants: rose, blackberry, raspberry bushes.

Treatment: Spray infested plants with kerosene emulsion or whale oil soap solution.

195 **Orange chaff scale insect,** Parlatoria pergandii Comst. Chief food plants: orange, tangerine.

It is limited to greenhouses in the north.

196 **Orange scale insect,** Mytilaspis citricola Pack. Occurs on oranges in the south and may infest trees kept in greenhouses in the north.

197 **Appletree bark louse,** Mytilaspis pomorum Bouché. Principal food plants: apple and many other trees.

Treatment: Spray young about June 1 with kerosene emulsion or whale oil soap solution.

Chief accessible articles: **Lintner, J. A.,** state ent. 4th rep't, '88. p. 114-20; **Howard, L. O.** U. S. dep't agric. Yearbook. '94. p. 254-59; **Felt, E. P.** N. Y. state mus. Bul. 46. '01. p. 297-300.

198 **Elm Chionaspis,** Chionaspis americana Johns. Rather common on American elm, rarely very injurious.

199 **Euonymus scale insect,** Chionaspis euonymi Comst. Principal food plant: Euonymus or strawberry tree.

200 **Scurfy bark louse,** Chionaspis furfura Fitch. Principal food plant: apple and other fruit trees.

Treatment: Spray young about June 1 with kerosene emulsion or whale oil soap solution.

Chief accessible articles: **Howard, L. O.** U. S. dep't agric. Yearbook. '94. p. 259-61; **Felt, E. P.** N. Y. state mus. Bul. 46. '01. p. 300-4.

201 **Pine leaf scale insect,** Chionaspis pinifoliae Fitch. Attacks various pines, specially those growing in parks.

Chief accessible notice: **Lintner, J. A.,** state ent. 11th rep't, '96. p. 203.

202 Hemichionaspis aspidistrae Sign. Infests ferns in greenhouses.

FOREST INSECTS (203-51)

General works on the group

Fitch, Asa. Noxious and beneficial insects of New York. 4th rep't, '57. p. 5-67; ——— ——— 5th rep't, '58. p. 1-74.

Packard, A. S. Forest insects. U. S. ent. com. 5th rep't, '90. p. 1-957.

Hopkins, A. D. Catalogue of West Virginia forest and shade tree insects. W. Va. agric. exp. sta. Bul. 32. '93. p. 171-251; ——— Preliminary report on the insect enemies of forests in the northwest. U. S. dep't agric. div. ent. Bul. 21, n. s. '99. p. 1-27.

Woodborers, various species.

203 Xiphydria provancheri Cr. A borer in paper birch, Adirondack region.

204 **Carpenter moth,** Prionoxystus robiniae Peck. A serious enemy of maple and oak trees.

205 **Pitch pine twig Tortrix,** Retinia comstockiana Fern. A twig-borer causing considerable exudations of pitch.

206 **Bronze birch borer,** Agrilus anxius Gory. Principal food plant: white birch, specially injurious in parks.

Treatment: Cut and burn badly infested trees.

Chief accessible article: **Chittenden, F. H.** U. S. dep't agric. div. ent. Bul. 18, n. s. '98. p. 44-51.

207 **Mapletree pruner,** Elaphidion villosum Fabr. Principal food plants: maple, oak.

Treatment: Gather and burn cut limbs in fall or early spring.

Chief accessible articles: **Lintner, J. A.,** state ent. 9th rep't, '92. p. 357-61; **Felt, E. P.** Fisheries, game and forest com. 4th rep't, sep. '98. p. 28-29.

208 **Pine sawyer,** Monohammus confusor Kirby. Attacks pines and spruces.

209 **Pine sawyer,** Monohammus scutellatus Say. Attacks pines.

210 Monohammus titillator Fabr. Attacks pines.

211 **Poplar borer,** Saperda calcarata Say. A serious enemy of poplars in some localities.

212 **Painted hickory borer,** Cyllene pictus Drury. Attacks hickory.

Chief accessible article: **Lintner, J. A.,** state ent. 8th rep't, '91. p. 175-76.

213 **Locust borer,** Cyllene robiniae Forst. A serious enemy of locusttrees.

Chief accessible article: **Hopkins, A. D.** W. Va. agric. exp. sta. Bul. 16. '91. p. 88.

214 **Ribbed Rhagium,** Rhagium lineatum Oliv. Works under dead or dying pine bark.

215 **White pine weevil,** Pissodes strobi Peck. Injures terminal shoots of pine.

216 **Willow snout beetle,** Cryptorhynchus lapathi Linn. An introduced borer which injures poplar and willow.

Bark and wood borers, Scolytids

General works on the group

Hopkins, A. D. Catalogue of West Virginia Scolytidae and their enemies. W. Va. agric. exp. sta. Bul. 31. '93. p. 121-68.

Hubbard, H. G. U. S. dep't agric. div. ent. Bul. 7, n. s. '97. p. 9-30.

217 Monarthrum mali Fitch. Attacks beech, apple.

Chief accessible article: **Fitch, Asa.** Noxious and beneficial insects of New York. 3d rep't, '56. p. 8-9.

218 Gnathotrichus materiarius Fitch. Attacks white and pitch pine.

219 Pityogenes sp. Attacks white pine.

220 Pityophthorus minutissimus Zimm. A bark-miner of red oak.

221 Pityophthorus sp. Working in dead limbs of black birch.

222 Xyloterus politus Say. Attacks beech and soft maple.

223 X. bivittatus Kirby. Attacks balsam stumps.

224 Cryphalus striatus Mann. Attacks balsam, spruce and hemlock.

225 Dryocoetes eichhoffi Hopk. Taken under bark of yellow birch stump.

226 Dryocoetes sp. Working in bark of spruce logs.

227 Xylocleptes sp. Boring in partly decayed twigs of sugar maple.

228 Tomicus calligraphus Germ. Abundant in thicker bark of dying white and pitch pines.

229 T. cacographus Lec. Works in the thinner bark of white and pitch pines.

230 T. pini Say. Sometimes abundant in bark of young white pines.

231 T. balsameus Lec. A serious enemy of balsam trees.

232 T. caelatus Eich. Works in thinner bark of white and pitch pines.

233 **Spruce bark beetle,** Polygraphus rufipennis Kirby. A serious enemy of the spruce and occurs occasionally in balsam trees.

234 Phlaeosinus dentatus Say. Attacks recently cut or dying arbor vitae.

235 **Boring Dendroctonus,** Dendroctonus terebrans Oliv. Attacks pitch pines.

Leaf feeders, etc.

236 **Pine sawfly,** Lophyrus lecontei Fitch. Strips the needles from white pines.

237 **Poplar sawfly,** Trichiocampus viminalis Fall. Attacks poplar.

Chief accessible article: **Lintner, J. A.,** state ent. 4th rep't, '88. p. 44-46.

238 **Cherry leaf beetle,** Galerucella cavicollis Lec. Feeds on wild cherry in Adirondacks, occasionally it attacks cultivated trees.

Treatment: Spray the foliage with an arsenical poison.

Chief accessible article: **Lintner, J. A.,** state ent. 11th rep't, '95. p. 197-98.

239 **Locust leaf-miner,** Odontota dorsalis Thunb. Attacks locust trees.

Chief accessible article: **Lintner, J. A.,** state ent. 12th rep't, '96. p. 264-67.

240 **Forest tent-caterpillar,** Clisiocampa disstria Hübn. Chief food plants: maple, elm, apple.

Treatment: Protect birds, collect eggs, spray domesticated trees with an arsenical poison.

Chief accessible articles: **Felt, E. P.**, state ent. 14th rep't, '98. p. 191-201; —— Fisheries, game and forest com. 4th rep't, sep. '98. p. 10-16; **Lowe, V. H.** N. Y. agric. exp. sta. Bul. 159. '99. p. 33-60; **Slingerland, M. V.** Cornell agric. exp. sta. Bul. 170. '99. p. 557-64; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59:275-76; —— state ent. 16th rep't, '01. p. 994-98.

241 Pimpla conquisitor Say. A parasite of 240.

242 Tachina mella Walk. A parasite of 240.

243 Theronia fulvescens Cress. A parasite of 240.

244 Pteromalus vanessae How. A parasite of 240.

245 **Fall webworm**, Hyphantria cunea Drury. Principal food plants: white elm, willows and poplars.

Treatment: Spray infested limbs with an arsenical poison.

Chief accessible articles: **Riley, C. V.** U. S. dep't agric. div. ent. Bul. 10. '87. p. 33-53; **Howard, L. O.** U. S. dep't agric. Yearbook. '95. p. 375-76; **Felt, E. P.** Fisheries, game and forest com. 5th rep't, '99. p. 363-68.

246 **Orange striped oak worm**, Anisota senatoria Abb. & Sm. Principal food plants: various species of oak.

Chief accessible article: **Lintner, J. A.**, state ent. 5th rep't, '89. p. 192-200.

247 **Hickory tussock moth**, Halisidota caryae Harris. Principal food plants: hickory, walnut, butternut.

248 **Cherrytree tortrix**, Cacoecia cerasivorana Fitch. Principal food plant: cherry, birch.

249 **Birch Bucculatrix**, Bucculatrix canadensisella Chamb. Sometimes very injurious to white birch.

250 **Maple leaf-miner**, Lithocolletis aceriella Clem. Attacks leaves of maples and witch-hazel.

251 **17 year cicada**, Cicada septendecim Linn. Injures twigs of many trees by cutting slits in them for the reception of eggs.

Chief accessible articles: **Lintner, J. A.**, state ent. 12th rep't, '96. p. 272-89; **Marlatt, C. L.** U. S. dep't agric. div. ent. Bul. 14. '98. p. 148.

SHADE TREE INSECTS (252-67)

252 **Mapletree borer,** Plagionotus speciosus Say. Principal food plant: sugar mapletrees.

Treatment: Dig out the young borers.

Chief accessible articles: **Lintner, J. A.,** state ent. 12th rep't, '96. p. 237-48; **Felt, E. P.** Fisheries, game and forest com. 4th rep't, sep. '98. p. 22-28; —— N. Y. state agric. soc. Trans. '99. 59:277-78.

253 **Leopard moth,** Zeuzera pyrina Fabr. Chief food plants: attacks a large number of trees.

Treatment: Destroy females, dig out young borers, kill larger ones in burrows with carbon bisulfid.

Chief accessible articles: **Lintner, J. A.** state ent. 9th rep't, '93. p. 426-27; **Felt, E. P.** Fisheries, game and forest com. 4th rep't, sep. '98. p. 16-20.

254 **Elm bark-borer,** Saperda tridentata Oliv. Principal food plant: American elm.

Treatment: Cut and burn badly infested trees or limbs.

Chief accessible articles: **Lintner, J. A.,** state ent. 12th rep't, '96. p. 243-48; **Felt, E. P.** N. Y. state agric. soc. Trans. '99. 59: 278-79; —— Fisheries, game and forest com. 5th rep't, '99. p. 371-75.

255 **Elm snout beetle,** Magdalis barbita Say. Principal food plant: American elm.

Treatment: Cut and burn badly infested limbs.

Chief accessible notices: **Felt, E. P.** N. Y. state mus. Bul. 37. '00. p. 22; —— Fisheries, game and forest com. 5th rep't, '99. p. 374.

256 **Pigeon tremex,** Tremex columba Linn. Principal food plants: diseased maples and elms.

Chief accessible notices: **Felt, E. P.** N. Y. state mus. Bul. 20. '98. p. 18-19; —— Fisheries, game and forest com. 4th rep't, '98. p. 25-26.

257 **Lunate long sting,** Thalessa lunator Fabr. A parasite of 256.

Chief accessible articles: **Lintner, J. A.**, state ent. 4th rep't, '88. p. 35-41; **Felt, E. P.** Fisheries, game and forest com. 4th rep't, sep. '98. p. 25-26.

258 **Elm bark louse,** Gossyparia ulmi Geoff. Chief food plants: European elms.

Treatment: Brush or wash off the bark lice, spray in July or early spring with kerosene emulsion or whale oil soap.

Chief accessible articles: **Lintner, J. A.**, state ent. 12th rep't, '96. p. 292-98; **Felt, E. P.** N. Y. state mus. Bul. 20. '98. p. 10-18; —— Fisheries, game and forest com. 5th rep't, '99. p. 375-79.

259 **Elm leaf beetle,** Galerucella luteola Müll. Principal food plants: European elms.

Treatment: Spray infested trees with arsenical poisons.

Chief accessible articles: **Lintner, J. A.**, state ent. 5th rep't, '89. p. 234-42; —— —— 11th rep't, '95. p. 189-96; **Howard, L. O.** U. S. dep't agric. Yearbook. '95. p. 363-68; **Lintner, J. A.** state ent. 12th rep't, '96. p. 253-64; **Felt, E. P.** N. Y. state mus. Bul. 20. '98. p. 1-43; —— state ent. 14th rep't, '98. p. 232-35; —— N. Y. state agric. soc. Trans. '99, 59:279; —— Fisheries, game and forest com. 5th rep't, '99. p. 354-59.

260 **Spined soldier bug,** Podisus spinosus Dall. An enemy of 259.

261 **Fungus disease,** Sporotrichum entomophilum Peck. An enemy of 259.

262 **White marked tussock moth,** Notolophus leucostigma Abb. & Sm. Principal food plants: horsechestnut, linden, maple and elm trees.

Treatment: Collect and destroy egg masses, spray infested trees with arsenical poisons.

Chief accessible articles: **Lintner, J. A.**, state ent. 2d rep't, '85. p. 68-89; —— 11th rep't, '95. p. 124-26; **Howard, L. O.** U. S. dep't. agric. Yearbook. '95. p. 368-75; **Felt, E. P.**, state ent. 14th rep't, '98. p. 163-76; —— Fisheries, game and forest com. 4th rep't, sep. '98. p. 4-10.

263 Pimpla conquisitor Say. A parasite of 262.

264 Tachina mella Walk. A parasite of 262.

265 **Bag worm,** Thyridopteryx ephemeraeformis Haw. Principal food plants: arbor vitae, red cedar.

Treatment: Hand picking, spray with arsenical poisons.

Chief accessible articles: **Lintner, J. A.,** state ent. 1st rep't, '82. p. 81-87; **Riley, C. V.** U. S. dep't agric. div. ent. Bul. 10. '87. p. 22-28; **Felt, E. P.** Fisheries, game and forest com. 5th rep't, '99. p. 359-63.

266 **Spiny elm caterpillar,** Euvanessa antiopa Linn. Principal food plants: elm, willow, poplar.

Treatment: Spray infested trees with arsenical poisons.

Chief accessible articles: **Weed, C. M.** N. H. agric. exp. sta. Bul. '67. '99. p. 125-41; **Felt, E. P.** Fisheries, game and forest com. 5th rep't, '99. p. 368-71.

267 Pteromalus fuscipes Prov. A parasite of 266.

WORK OF GALL INSECTS (268-97)

Galls of sawflies, Tenthredinidae

268 **Willow apple gall,** Pontania pomum Walsh

4 winged gallflies, Cynipidae

269 **Mealy rose gall,** Rhodites ignota O. S.

270 **Mossy rose gall,** Rhodites rosae Linn.

271 **Large oak apple,** Amphibolips confluentus Harr.

272 **Black scrub oak apple,** Amphibolips ilicifoliae Bass.

273 **Oak plum gall,** Amphibolips prunus Walsh

274 **Gall of wool sower,** Andricus seminator Harris

275 **Oak leaf-stalk gall,** Andricus petiolicola Bass.

276 **Oak-wool gall,** Andricus lana Fitch

277 **Woolly oak gall,** Andricus operator O. S.

278 **Fuzzy chestnut leaf gall,** ? Cynips prinoides Beutm.

279 **Lobed oak gall,** Cynips strobilana O. S.

280 Cynips decidua Bass.

281 **Oak fig gall,** Biorhiza fortcornis Walsh

282 **Larger empty oak apple,** Holcaspis inanis O. S.

283 **Bullet gall,** Holcaspis globulus Fitch
284 **Rough bullet gall,** Holcaspis duricola Bass.
285 **Oak leaf bullet gall,** Dryophanta polita Bass.
286 **Oak potato gall,** Neuroterus batatus Fitch

2 winged gallflies, Diptera

Gall gnats, Cecidomyiidae

287 **Hickory leaf gall,** Cecidomyia holotricha O. S.
288 **Willow cone gall,** Cecidomyia strobiloides O. S.
289 **Balsam leaf gall,** Cecidomyia balsamicola Lintn.

Trypetid galls

290 **Small solidago gall,** Trypeta polita Loew
291 **Large solidago gall,** Trypeta solidaginis Fitch

Psyllid galls, Psyllidae

292 **Hackberry leaf gall,** Pachypsylla celtidis-mamma Riley

Galls of plant lice, Aphididae

293 **Witch-hazel gall,** Hormaphis hamamelidis Fitch
294 **Cockscomb elm gall,** Colopha ulmicola Fitch
295 **Poplar leaf stem gall,** Pemphigus populi-transversus Riley
296 **Phylloxera galls,** Phylloxera vitifoliae Fitch
297 **Larch aphid gall,** Chermes abietis Linn.

BEE AND WASP FAMILY, Hymenoptera **(298-384)**

Long-tongued bees Apidae

298 **Honey bee,** Apis mellifica Linn.
299 Bombus virginicus Oliv.
300 B. vagans Smith
301 B. terricola Kirby
302 B. ternarius Say
303 B. fervidus Fabr.
304 Psithyrus elatus Fabr.
305 P. ashtoni Cr.

306 Xylocopa virginica Drury
307 Clisodon terminalis Cr.
308 Melissodes perplexa Cr.
309 M. aurigenia Cr.
310 Ceratina dupla Say
311 Megachile montivaga Cr.
312 M. melanophaea Smith
313 M. latimanus Say
314 Alcidamea producta Cr.
315 Andronicus cylindricus Cr.
316 Osmia lignaria Say
317 Stelis lateralis Cr.

Short-tongued bees Andrenidae

318 Andrena vicina Smith
319 A. nubecula Smith
320 A. forbesii Rob.
321 A. crataegi Rob.
322 Augochlora pura Say
323 Halictus zephyrus Smith
324 H. pilosus Smith
325 H. confusus Smith
326 Sphecodes arvensis Pttn.
327 Prosopis elliptica Kirby
328 P. affinis Smith
329 Colletes inaequalis Say

Social wasps, Vespidae

330 Vespa vulgaris Linn.
331 **White-faced hornet,** Vespa maculata Linn.
332 Vespa germanica Fabr.
333 **Yellow jacket,** Vespa diabolica Sauss.
334 Vespa consobrina Sauss.
335 V. arenaria Fabr.
336 **Common wasp,** Polistes pallipes St Farg.

Solitary wasps, Eumenidae

337 Odynerus unifasciatus Sauss.
338 O. philadelphiae Sauss.

Crabronidae

339 Crabro trifasciatus Say
340 C. 6-maculatus Say
341 C. producticollis Pack.
342 C. interruptus St Farg.

Pemphredonidae

343 Pemphredon concolor Say

Philanthidae

344 Cerceris dentifrons Cr.
345 Philanthus bilunatus Cr.

Nyssonidae

346 Hoplisus phaleratus Say

Bembecidae

347 Monedula ventralis Say
348 M. 4-fasciata Say
349 Microbembex monodonta Say
350 Bembex fasciata Fabr.

Thread-waisted wasps, Sphecidae

351 Sphex ichneumonea Linn.
352 Isodontia philadelphica St Farg.
353 **Mud dauber,** Chalybion caeruleum Linn.
354 **Mud dauber,** Pelopoeus cementarius Drury
355 Ammophila gracilis St Farg.
356 A. communis Cr.

Spider wasps, Pompilidae

357 Pompilus marginatus Say
358 P. aethiops Cr.

Scoliidae

359 Myzine 6-cincta Fabr.
360 Tiphia inornata Say

Ants, Formicidae

361 Camponotus herculaneus Linn.

Cuckoo flies, Chrysididae

362 ?Chrysis sp.

Pelecinidae

363 Pelecinus polyturator Drury

Chalcis flies, Chalcididae

364 Dibrachys boucheanus Ratz.
365 Pteromalus vanessae How.
366 P. cuproideus How.
367 Isosoma captivum How.

Braconidae

368 Apanteles congregatus Say

Ichneumon flies, Ichneumonidae

369 Pimpla inquisitor Say
370 **Lunate long sting,** Thalessa lunator Fabr.
371 **Black long sting,** Thalessa atrata Fabr.
372 Opheltes glaucopterus Linn.
373 Exochilum mundum Say
374 Ophion purgatum Say
375 Cryptus nuncius Say
376 Ichneumon laetus Brullé

Ensign flies, Evaniidae

377 Foenus tarsatorius Say

Gallflies, Cynipidae

378 Holcaspis duricola Bass

Horntails, Uroceridae

379 **Pigeon tremex,** Tremex columba Linn.
380 Xiphydria provancheri Cr.
381 **Currant stem girdler,** Janus integer Nort.

Sawflies, Tenthredinidae

382 Tenthredo rufipes Fabr.
383 Allantus basilaris Say
384 **American sawfly,** Cimbex americana Leach

BEETLES, Coleoptera (385-597)

Anthribidae

385 Cratoparis lunatus Fabr.

Bark-borers, Scolytidae

386 Phloeotribus frontalis Oliv.

387 **Spruce bark beetle,** Polygraphus rufipennis Kirby

388 **Fruit tree bark beetle,** Scolytus rugulosus Ratz.

389 Tomicus balsameus Lec.

390 T. pini Say

391 T. calligraphus Germ.

392 Xyloterus politus Say

393 Pityogenes *sp.*

394 Pityophthorus minutissimus Zimm.

395 Pityophthorus *sp.*

Bill bugs, Calandridae

396 **Grain weevil,** Calandra granaria Linn.

Brenthidae

397 Eupsalis minuta Drury

Snout beetles, Curculionidae

398 Mononychus vulpeculus Fabr.

399 **Willow snout beetle,** Cryptorhynchus lapathi Linn.

400 **Plum curculio,** Conotrachelus nenuphar Herbst

401 **Elm snout beetle,** Magdalis armicollis Say

402 **Rhubarb curculio,** Lixus concavus Say

403 **Punctured clover leaf weevil,** Phytonomus punctatus Fabr.

404 **New York weevil,** Ithycerus noveboracensis Forst.

Scarred snout beetles, Otiorhynchidae

405 Aphrastus taeniatus Gyll.

Rhynchitidae

406 Rhynchites bicolor Fabr.

Blister beetles, Meloidae

407 **Say's blister beetle,** Pomphopoea sayi Lec.

408 **Black blister beetle,** Epicauta pennsylvanica DeG.

409 **Striped blister beetle,** Epicauta vittata Fabr.

410 Meloe angusticollis Say

Anthicidae

411 Notoxus anchora Hentz.

Pythidae

412 Pytho americanus Kirby

Melandryidae

413 Penthe obliquata Fabr.

Darkling beetles, Tenebrionidae

414 **Forked fungus beetle,** Boletotherus bifurcus Fabr.

415 Hoplocephala bicornis Oliv.

416 **Meal worm,** Tenebrio molitor Linn.

417 Scotobates calcaratus Fabr.

418 Upis ceramboides Linn.

419 Iphthimus opacus Lec.

420 Alobates pennsylvanica DeG.

Weevils, Bruchidae

421 **Bean weevil,** Bruchus obtectus Say

Leaf beetles, Chrysomelidae

422 **Argus beetle,** Chelymorpha argus Licht.

423 **Clubbed tortoise beetle,** Coptocycla clavata Fabr.

424 **Spotted tortoise beetle,** Coptocycla signifera Herbst

425 **Golden tortoise beetle,** Coptocycla bicolor Fabr.

426 Disonycha caroliniana Fabr.

427 **Elm leaf beetle,** Galerucella luteola Müll

428 Trirhabda canadensis Kirby

429 **Striped cucumber beetle,** Diabrotica vittata Fabr.

430 **Willow leaf beetle,** Lina scripta Fabr.
431 Gastroidea polygoni Linn.
432 Chrysomela bigsbyana Kirby
433 C. philadelphica Linn.
434 C. scalaris Lec.
435 C. elegans Oliv.
436 C. similis Rog.
437 **Potato beetle,** Doryphora 10-lineata Say
438 **Three spotted Doryphora,** Doryphora clivicollis Kirby
439 **Gold gilt beetle,** Chrysochus auratus Fabr.
440 Chlamys plicata Fabr.
441 **Twelve spotted asparagus beetle,** Crioceris 12-punctata Linn.
442 **Asparagus beetle,** Crioceris asparagi Linn.
443 **Three lined Lema,** Lema trilineata Oliv.
444 Donacia femoralis Kirby

Long-horned woodborers, Cerambycidae

445 **Spotted milkweed beetle,** Tetraopes tetraopthalmus Forst.
446 Saperda puncticollis Say
447 S. lateralis Fabr.
448 S. vestita Say
449 Liopus variegatus Hald.
450 Monohammus maculosus Hald.
451 Leptura vittata Germ.
452 L. proxima Say
453 L. vagans Oliv.
454 L. rubrica Say
455 L. canadensis Fabr.
456 L. cordifera Oliv.
457 Typocerus velutinus Oliv.
458 **Cloaked knotty horn,** Desmocerus palliatus Forst.
459 Euderces picipes Fabr.
460 Clytanthus ruricola Oliv.

461 Neoclytus erythrocephalus Fabr.
462 Xylotrechus undulatus Say
463 X. colonus Fabr.
464 Arhopalus fulminans Fabr.
465 Phymatodes variabilis Fabr.
466 Physocnemum brevilineum Say
467 Criocephalus agrestis Kirby
468 **Broad-necked Prionus,** Prionus laticollis Drury
469 **Straight-bodied Prionid,** Orthosoma brunneum Forst.

Spondylidae

470 Parandra brunnea Fabr.

Lamellicorn beetles, Scarabaeidae

471 Trichius affinis Gory
472 **Rough flower beetle,** Osmoderma scabra Beauv.
473 **Hermit flower beetle,** Osmoderma eremicola Knoch.
474 **Green June beetle,** Allorhina nitida Linn.
475 **Spotted grapevine beetle,** Pelidnota punctata Linn.
476 **Light-loving grapevine beetle,** Anomala lucicola Fabr.
477 **June beetle,** Lachnosterna tristis Fabr.
478 **Earth-boring dung beetle,** Geotrupes egeriei Germ.
479 **Dung beetle,** Aphodius fimetarius Linn.
480 **Tumble bug,** Copris anaglypticus Say
481 **Tumble bug,** Canthon laevis Drury

Stag beetles, Lucanidae

482 **Horned passalus,** Passalus cornutus Fabr.
483 **Antelope beetle,** Dorcus parallelus Say
484 **Stag beetle,** Lucanus dama Thunb.

Checkered beetles, Cleridae

485 Clerus analis Lec.
486 Trichodes nuttalli Kirby

Fireflies, Lampyridae

487 **Soldier beetle**, Chauliognathus pennsylvanicus DeG.

488 Photuris pennsylvanica DeG.

489 Ellychnia corrusca Linn.

490 Eros aurora Herbst

491 Calopteron reticulatum Fabr.

Flat-headed woodborers, Buprestidae

492 **Bronze birch borer**, Agrilus anxius Gory

493 **Gouty gall beetle**, Agrilus ruficollis Fabr.

494 Chrysobothris dentipes Germ.

495 **Banded buprestid**, Buprestis fasciata Fabr.

496 Dicerca divaricata Say

497 Chalcophora liberta Germ.

498 C. virginiensis Drury

Snapping beetles, Elateridae

499 Asaphes baridius Say

500 Corymbites hieroglyphicus Say

501 C. vernalis Hentz.

502 Ludius abruptus Say

503 Elater nigricollis Herbst

504 Alaus myops Fabr.

505 **Owl beetle**, Alaus oculatus Linn.

506 Adelocera brevicornis Lec.

Nitidulidae

507 **Banded Ips**, Ips quadriguttatus Fabr.

508 Omosita colon Linn.

509 Nitidula bipustulata Linn.

Histeridae

510 Hister lecontei Mars.

511 H. americanus Payk.

512 H. furtivus Say

513 H. abbreviatus Fabr.

Dermestids, Dermestidae

514 Anthrenus verbasci Linn.

515 **Buffalo carpet beetle**, Anthrenus scrophulariae Linn.

516 **Black carpet beetle**, Attagenus piceus Oliv.

517 **Larder beetle**, Dermestes lardarius Linn.

518 Dermestes caninus Germ.

519 **Pale brown Byturus**, Byturus unicolor Say

Cucujids, Cucujidae

520 Brontes dubius Fabr.

521 Cathartus gemellatus Duv.

522 **Corn Silvanus**, Silvanus surinamensis Linn.

Erotylidae

523 Megalodacne heros Say

Lady bugs, Coccinellidae

524 **Northern lady bug**, Epilachna borealis Fabr.

525 Brachyacantha ursina Fabr.

526 **Twice stabbed lady bug**, Chilocorus bivulnerus Muls.

527 **15 spotted lady bug**, Anatis ocellata Linn.

528 **Two spotted lady bug**, Adalia bipunctata Linn.

529 Coccinella sanguinea Linn.

530 **Nine spotted lady bug**, Coccinella 9-notata Herbst

531 **Three banded lady bug**, Coccinella trifasciata Linn.

532 **Parenthetical lady bug**, Hippodamia parenthesis Say

533 **13 spotted lady bug**, Hippodamia 13-punctata Linn.

534 **Convergent lady bug**, Hippodamia convergens Guer.

535 **Spotted lady bug**, Megilla maculata DeG.

Rove beetles, Staphylinidae

536 Paederus littorarius Grav.

537 Staphylinus cinnamopterus Grav.

538 S. maculosus Grav.
539 Creophilus villosus Grav.
540 Listotrophus cingulatus Grav.

Carrion beetles, Silphidae

Carrion beetles, Silpha

541 Silpha americana Linn.
542 S. noveboracensis Forst.
543 S. inaequalis Fabr.
544 S. lapponica Herbst
545 S. surinamensis Fabr.

Burying beetles, Necrophorus

546 Necrophorus tomentosus Web.
547 N. marginatus Fabr.
548 N. americanus Oliv.

Scavenger water beetles, Hydrophilidae

549 Sphaeridium scarabaeoides Linn.
550 Hydrobius fuscipes Linn.
551 H. globosus Say
552 Philhydrus cinctus Say
553 Laccobius agilis Rand.
554 Hydrocharis obtusatus Say
555 Hydrophilus glaber Herbst
556 H. mixtus Lec.
557 H. nimbatus Say
558 H. triangularis Say
559 Helophorus lineatus Say

Whirligig beetles, Gyrinidae

560 Dineutes discolor Aubé.
561 Gyrinus picipes Aubé.
562 G. consobrinus Lec.
563 G. ventralis Kirby
564 G. minutus Fabr.

Predaceous diving beetles, Dytiscidae

565 Acilius semisulcatus Aubé.
566 Colymbetes sculptilis Harris

567 Rhantus binotatus Harris
568 Agabus gagates Aubé.
569 A. punctulatus Aubé.
570 Ilybius biguttalus Germ.
571 Deronectes griseostriatus DeG.
572 Laccophilus maculosus Germ.

Haliplidae

573 Haliplus ruficollis DeG.
574 H. fasciatus Aubé.

Ground beetles, Carabidae

575 Anisodactylus baltimorensis Say
576 **Pennsylvanian ground beetle,** Harpalus pennsylvanicus DeG.
577 **Dark ground beetle,** Harpalus caliginosus Fabr.
578 Chlaenius tricolor Dej.
579 C. sericeus Forst.
580 Galerita janus Fabr.
581 Casnonia pennsylvanica Linn.
582 Platynus cupripennis Say
583 Calathus gregarius Say
584 Dicaelus elongatus Bon.
585 Pterostichus lucublandus Say
586 P. stygicus Say
587 Scarites subterraneus Fabr.
588 Elaphrus ruscarius Say
589 **Fiery hunter,** Calosoma calidum Fabr.
590 **Searcher,** Calosoma scrutator Fabr.
591 Carabus vinctus Web.

Tiger beetles, Cicindelidae

592 **Repand tiger beetle,** Cicindela repanda Dej.
593 **Common tiger beetle,** Cicindela vulgaris Say
594 **Noble tiger beetle,** Cicindela generosa Dej.
595 **Purple tiger beetle,** Cicindela purpurea Oliv.
596 **Six spotted tiger beetle,** Cicindela 6-guttata Fabr.
597 Cicindela longilabris Say

FLEAS, Siphonaptera

598 **Dog and cat flea,** Ceratopsyllus serraticeps Gerv.

TWO-WINGED FLIES, Diptera (599-653)

Humpbacked flies, Phoridae

599 **Mushroom Phora,** Phora agarici Lintn.

Phytomyzidae

600 **Chrysanthemum fly,** Phytomyza chrysanthemi Kow.

Grain flies, Oscinidae

601 **Prolific Chlorops,** Chloropisca variceps Loew

Trypetidae

602 Trypeta festiva Loew
603 T. sparsa Wied.
604 T. florescentiae Linn.
605 T. longipennis Wied.

Ortalidae

606 Seoptera colon Harris
607 Rivellia viridulans R. Desv.

Dung flies, Cordyluridae

608 Scatophaga stercoraria Linn.

Anthomyiids, Anthomyiidae

609 **Locust egg anthomyian,** Phorbia fusciceps Zett.

House fly family, Muscidae

610 **House fly,** Musca domestica Linn.
611 **Cluster fly,** Pollenia rudis Fabr.
612 **Horn fly,** Haematobia serrata R. Desv.
613 **Stable fly,** Stomoxys calcitrans Linn.

Flesh flies, Sarcophagidae

614 Sarcophaga sp.

Tachina flies, Tachinidae

615 Tachina mella Walk.
616 Bombyliomyia abrupta Wied.

Syrphus flies, Syrphidae

617 Spilomyia fusca Loew
618 Helophilus similis Macq.
619 Eristalis transversus Wied.
620 E. tenax Linn.
621 E. androclus O. S.
622 E. flavipes Walk.
623 E. bastardi Macq.
624 Sericomyia limbipennis Macq.
625 Rhingia nasica Say
626 Sphaerophoria cylindrica Say
627 Syrphus americanus Wied.
628 S. lapponicus Zett.

Bee flies, Bombyliidae

629 Bombylius fratellus Wied.
630 Argyramoeba simson Fabr.
631 A. analis Say
632 Anthrax sinuosa Wied.
633 A. tegminipennis Say
634 A. fulviana Say
635 A. alternata Say
636 Exoprosopa dorcadion O. S.

Robber flies, Asilidae

637 Diogmites discolor Loew

Snipe flies, Leptidae

638 Leptis punctipennis Say
639 Chrysopila thoracica Fabr.

Horse flies, Tabanidae

640 Tabanus reinwardtii Wied.
641 **Mourning horse fly,** Tabanus atratus Fabr.
642 **Banded horse fly,** Therioplectes cinctus Fabr.
643 Chrysops niger Macq.

Soldier flies, Stratiomyiidae

644 Stratiomyia picipes Loew
645 Metoponia fuscitarsis Say

Crane flies, Tipulidae

646 Tipula fuliginosa Say

March flies, Bibionidae

647 Scatopse notata Linn.

648 Bibio albipennis Say

Black flies, Simuliidae

649 **Southern Buffalo gnat,** Simulium invenustum Walk.

Fungus gnats, Mycetophilidae

650 **Manure fly,** Sciara coprophila Lintn.

651 Asyndulum montanum Roed.

Gall gnats, Cecidomyiidae

652 **Birch seed midge,** Cecidomyia betulae Wintz.

653 **Hessian fly,** Cecidomyia destructor Say

BUTTERFLIES AND MOTHS, Lepidoptera (654-828)

BUTTERFLIES, Rhopalocera (654-722)

Four-footed butterflies, Nymphalidae

654 **Milkweed butterfly,** Anosia plexippus Linn.

655 Agraulis vanillae Linn.

656 Thyridia psidii Linn.

657 Lycorea pasinuntia Cram.

658 **Regal fritillary,** Speyria idalia Drury

659 **Great spangled fritillary,** Argynnis cybele Fabr.

660 **Silver spot fritillary,** Argynnis aphrodite var. alcestis Edw.

661 **Mountain silver spot,** Argynnis atlantis Edw.

662 **Meadow fritillary,** Brenthis bellona Fabr.

663 Pyrrhopyge acastus Cram.

664 P. phidias Linn.

665 **Pearl crescent,** Phyciodes tharos var. morpheus Edw.

666 **Violet tip,** Polygonia interrogationis var. umbrosa Lintn.

667 **Hop merchant,** Polygonia comma var. harrisii Edw.

668 **Green comma,** Polygonia faunus Edw.
669 **Gray comma,** Polygonia progne Cram.
670 **Compton tortoise,** Eugonia j-album Boisd. & Lec.
671 **Mourning cloak,** Euvanessa antiopa Linn.
672 **American tortoise shell,** Aglais milberti Godt.
673 **Red admiral,** Vanessa atalanta Linn.
674 **Painted beauty,** Vanessa huntera Fabr.
675 **Buckeye,** Junonia coenia Hübn.
676 Anartia amalthea Linn.
677 **Red spotted purple,** Basilarchia astyanax Fabr.
678 **Banded purple,** Basilarchia arthemis Drury
679 **Bastard purple,** Basilarchia proserpina Edw.
680 **Viceroy,** Basilarchia archippus Cram.
681 Ageronia feronia Hübn.
682 A. fornax Hübn.
683 **Eyed brown,** Satyrodes eurydice Linn. & Joh.
684 **Little wood satyr,** Cissia eurytus Fabr.
685 **Dull-eyed grayling,** Cercyonis nephele Kirby
686 **Blue-eyed grayling,** Cercyonis alope Fabr.

Gossamer-winged butterflies, Lycaenidae

687 **Hoary elfin,** Incisalia irus Godt.
688 **Wanderer,** Feneseca tarquinius Fabr.
689 **American copper,** Heodes hypophlaeas Boisd.
690 **Pearl studded violet,** Rusticus scudderii Edw.
691 **Spring azure,** Cyaniris pseudargiolus Boisd. & Lec.
692 **Tailed blue,** Everes comyntas Godt.

Pierids, Pieridae

693 ?Eronia argia Fabr. (Africa)
694 **Checkered white,** Pontia protodice Boisd. & Lec.
695 **Gray-veined white,** Pieris oleracea Harris
696 **Cabbage butterfly,** Pieris rapae Linn.
697 Catopsilia menippe Hübn.
698 ?C. statira Cram.
699 **Cloudless sulfur,** Callidryas eubule Linn.

700 Zerene cesonia Stoll.
701 **Clouded sulfur,** Eurymus philodice Godt.
702 Eurymus philodice pallidice Scudd.
703 **Little sulfur,** Eurema lisa Boisd. & Lec.

Swallowtails, Papilionidae

704 Iphiclides sp.
705 **Zebra swallowtail,** Iphiclides ajax telamonoides Feld.
706 **Tiger swallowtail,** Jasoniades glaucus turnus Linn.
707 **Black swallowtail,** Papilio polyxenes Fabr.
708 ?Papilio dolichaon Cram.
709 P. sarpedon Linn.
710 **Green clouded swallowtail,** Euphoeades troilus Linn.
711 **Blue swallowtail,** Laertias philenor Linn.

Common skippers, Hesperiidae

712 **Least skipper,** Ancyloxipha numitor Fabr.
713 **Mormon,** Atrytone zabulon Boisd. & Lec.
714 **Yellow spot,** Polites peckius Kirby
715 **Long dash,** Thymelicus mystic Edw.
716 **Tawny edged skipper,** Limochores taumas Fabr.
717 **Dun skipper,** Euphyes metacomet Harris
718 **Dusted skipper,** Lerema hianna Scudd.
719 **Dreamy dusky wing,** Thanaos icelus Lintn.
720 **Martial's dusky wing,** Thanaos martialis Scudd.
721 **Sooty wing,** Pholisora catullus Fabr.
722 **Silver spotted skipper,** Epargyreus tityrus Fabr.

MOTHS, Heterocera **(723-828)**

Hawk moths, Sphingidae

723 **Bumblebee hawk moth,** Hemaris diffinis Boisd.
724 Amphion nessus Cram.
725 Deidamia inscripta Harris
726 **White lined sphinx,** Deilephila lineata Fabr.
727 **Grapevine hog caterpillar,** Ampelophaga myron Cram.

728 **Pen-marked sphinx,** Sphinx chersis Hübn.

729 Sphinx eremitis Hübn.

730 Ceratomia amyntor Hübn.

Clear-winged moths, Sesiidae

731 **Currant stem-borer,** Sesia tipuliformis Linn.

Wood nymph moths, Agaristidae

732 **Eight spotted forester,** Alypia octomaculata Fabr.

Zygaenidae

733 Lycomorpha pholus Drury

734 Ctenucha virginica Charp.

Footman moths, Lithosiidae

735 Hypoprepia fucosa Hübn.

Tiger moths, Arctiidae

736 **Bella moth,** Utetheisa bella Linn.

737 Haploa confusa Lyman

738 **Tiger moth,** Euprepia virgo Linn.

739 **Isabella tiger moth,** Pyrrharctia isabella Abb. & Sm.

740 **Salt marsh caterpillar,** Estigmene acraea Drury

741 **Harlequin milkweed caterpillar,** Cycnia egle Drury

742 Halisidota tessellaris Abb. & Sm.

743 **Hickory tussock moth,** Halisidota caryae Harris

Tussock moths, Lymantriidae

744 Notolophus antiqua Linn.

745 **Gipsy moth,** Porthetria dispar Linn.

Flannel moths, Megalopygidae

746 **Crinkled flannel moth,** Megalopyge crispata Pack.

Bag worm moths, Psychidae

747 **Bag worm moth,** Thyridopteryx ephemeraeformis Haw.

Prominents, Notodontidae

748 Cerura cinerea Walk.

Giant silk worms, Saturniidae

749 **Luna moth,** Tropaea luna Linn.

750 **Io moth,** Automeris io Fabr.

Royal moths, Citheroniidae

751 **Regal moth,** Citheronia regalis Fabr.

752 **Rosy anisota,** Anisota rubicunda Fabr.

Lasiocampidae

753 **Tent-caterpillar moth,** Clisiocampa americana Fabr.

Carpenter moths, Cossidae

754 **Carpenter moth,** Prionoxystus robiniae Peck

Cymatophoridae

755 Thyatira scripta Gosse.

Owlet moths, Noctuidae

756 Acronycta americana Harris

757 Feltia subgothica Haw.

758 Xylophasia arctica Boisd.

759 Trigonophora periculosa Guen.

760 Leucania pallens Linn.

761 **Pyramidal grapevine caterpillar,** Amphipyra pyramidoides Guen.

762 Orthosia helva Grt.

763 Cirroedia pampina Guen.

764 Scoliopteryx libatrix Linn.

765 Scopelosoma indirecta Walk.

766 Cucullia asteroides Guen.

767 **Cotton worm moth,** Aletia argillacea Hübn.

768 Plusia balluca Geyer

769 P. mortuorum Guen.

770 **Boll worm moth,** Heliothis armiger Hübn.

771 Alaria florida Guen.

772 Melaporphyria immortua Grt.

773 Erastria concinnimacula Guen.

774 Catocala cerogama Guen.

775 C. ultronia Hübn.

776 C. unijuga Walk.
777 C. cara Guen.
778 Parallelia bistriaris Hübn.
779 Panapoda rufimargo var. carneicosta Guen.
780 Zale horrida Hübn.
781 Homoptera lunata Drury
782 H. minerea Guen.

Measuring worms, Geometridae

783 Sabulodes transversata Drury
784 Tetracis crocallata Guen.
785 Metanema inatomaria Guen.
786 Caberodes confusaria Hübn.
787 Ennomos subsignarius Hübn.
788 Azelina peplaria Hübn.
789 Euchlaena effectaria Walk.
790 Xanthotype crocataria Fabr.
791 Plagodis phlogosaria Guen.
792 Synchlora glaucaria Guen.
793 Deilinia erythremaria Guen.
794 Eudeilinia ?herminiata Guen.
795 Orthofidonia semiclarata Walk.
796 Sciagraphia mellistrigata Grt.
797 Caripeta angustiorata Walk.
798 Epelis faxonii Minot
799 Cingilia catenaria Cram.
800 Nepytia semiclusaria Walk.
801 Lycia cognataria Guen.
802 Euchoeca albovittata Guen.
803 Eucymatoge intestinata Guen.
804 Eustroma diversilineatum Hübn.
805 Mesoleuca hersiliata Guen.
806 M. ruficiliata Guen.
807 M. lacustrata Guen.
808 Gypsochroa designata Bork.

Pyraustidae

809 **Grape leaf-folder,** Desmia funeralis Hübn.
810 Pyrausta theseusalis Walk.
811 Pantographa limata Grt. & Rob.
812 Evergestis straminalis Hübn.
813 Cataclysta ?opulentalis Led.

Phycitidae

814 Acrobasis rubrifasciella Pack.

Close wings, Crambidae

815 Argyria nivalis Drury
816 **Wide-striped Crambus,** Crambus unistriatellus Pack.
817 Crambus hastiferellus Walk.
818 **Unmarked Crambus,** Crambus perlellus Scop.
819 **Dark spotted Crambus,** Crambus mutabilis Clem.

Plume moths, Pterophoridae

820 Platyptilia ochrodactyla Hübn.
821 **Grapevine plume moth,** Oxyptilus periscelidactylus Fitch

Leaf-rollers, Tortricidae

822 Teras logiana var. viburnana Clem.
823 **Oblique banded leaf-roller,** Cacoecia rosaceana Harris
824 **Ugly nest tortricid,** Cacoecia cerasivorana Fitch
825 **V-marked tortrix,** Cacoecia argyrospila Walk.
826 Cenopis reticulatana Clem.

Grapholithidae

827 **Rose leaf tier,** Penthina nimbatana Clem.

Tineina

828 **Angoumois grain moth,** Sitotroga cerealella Oliv.

CADDIS FLIES, Trichoptera **(829-37)**

829 Platyphylax subfasciata Say

SCORPION FLIES, Mecoptera

830 Panorpa rufescens Ramb.

831 Bittacus strigosus Hagen

DOBSON AND OTHERS, Neuroptera

832 **Ant lion,** Myrmeleon immaculatus DeGeer

833 Polystoechotes punctatus Fabr.

834 **Lace-winged fly,** Chrysopa ?perla

835 Sialis infirma Newm.

836 **Dobson,** Corydalis cornuta Linn.

837 **Comb-horned fish fly,** Chauliodes serraticornis Say

TRUE BUGS, Hemiptera (838-81)

Leaf hoppers, Jassidae

838 **Grapevine leaf hopper,** Typhlocyba comes Say

839 **Red lined leaf hopper,** Diedrocephala coccinea Forst.

Tree hoppers, Membracidae

840 **Woodbine Telamona,** Telamona ampelopsidis Harris

841 **Two spotted Enchenopa,** Enchenopa binotata Say

842 Stictocephala inermis Fabr.

843 **Buffalo tree hopper,** Ceresa bubalus Fabr.

Spittle insects, Cercopidae

844 Lepyronia 4-angularis Say

Cicadas, Cicadidae

845 **Dog day cicada,** Cicada tibicen Linn.

Lantern fly family, Fulgoridae

846 Ormenis pruinosa Say

Plant lice, Aphididae

847 **Cherry aphis,** Myzus cerasi Fabr.

848 Pemphigus acerifolii Riley

Water boatmen, Corixidae

849 Corixa interrupta Say

Back swimmers, Notonectidae

850 Notonecta undulata Say

Water scorpions, Nepidae

851 Nepa apiculata Uhl.

Giant water bugs, Belostomidae

852 Belostoma americanum Leidy

853 Zaitha aurantiacum Leidy

Water striders, Hydrobatidae

854 Hygrotrechus conformis Uhl.

855 Limmoporus rufoscutellatus Lat.

Reduviidae

856 **Kissing bug,** Opsicoetus personatus Linn.

857 Acholla multispinosa DeG.

Ambush bugs, Phymatidae

858 Phymata wolffii Stal.

Leaf bugs, Capsidae

859 **Tarnished plant bug,** Lygus pratensis Linn.

860 Calocoris rapidus Say

861 Garganus fusiformis Say

862 Capsus ater Linn.

863 **Four lined leaf bug,** Poecilocapsus lineatus Fabr.

864 Leptopterna dolobrata Linn.

865 Brachytropis calcarata Fall.

Chinch bug family, Lygaeidae

866 Lygaeus turcicus Fabr.

867 **Chinch bug,** Blissus leucopterus Say

Squash bug family, Coreidae

868 **Box elder plant bug,** Leptocoris trivittatus Say

869 **Squash bug,** Anasa tristis DeG.

Stink bug family, Pentatomidae

870 Nezara hilaris Say

871 **Harlequin cabbage bug,** Murgantia histrionica Hahn.

872 **Juniper plant bug,** Pentatoma juniperina Linn.
873 Euschistus fissilis Uhl.
874 Mormidea lugens Fabr.
875 Cosmopepla carnifex Fabr.
876 Podisus serieventris Uhl.
877 P. cynicus Say

Burrowing bugs, Cydnidae

878 Canthophorus cinctus Beauv.

Shield-backed bugs, Scutelleridae

879 Eurygaster alternatus Say

Lice, Pediculidae

880 **Short-nosed cattle louse,** Haematopinus eurysternus Nitzsch
881 **Hog louse,** Haematopinus urius Nitzsch

THRIPS, Physopoda

882 **Onion thrips,** Thrips tabaci Lind.

GRASSHOPPERS, LOCUSTS, Orthoptera (883-903)

Short-horned grasshoppers, Acrididae

883 **Green striped locust,** Chortophaga viridifasciata DeG.
884 **Clouded locust,** Encoptolophus sordidus Burm.
885 **Carolina locust,** Dissosteira carolina Linn.
886 **Red-legged locust,** Melanoplus femur-rubrum DeG.
887 **Lesser migratory locust,** Melanoplus atlanis Riley
888 Melanoplus femoratus Burm.
889 **Coral-winged locust,** Hippiscus tuberculatus Beauv.
890 **Pellucid locust,** Camnula pellucida Scudd.
891 Circotettix verruculatus Scudd.

Long-horned grasshoppers, Locustidae

892 **Oblong leaf-winged katydid,** Amblycorypha oblongifolia DeG.

893 **Broad-winged katydid,** Cyrtophyllus concavus Harris

894 **Cone-headed katydid,** Conocephalus ensiger Harris

895 **Spotted wingless grasshopper,** Ceuthophilus maculatus Say

Crickets, Gryllidae

896 **Common cricket,** Gryllus abbreviatus Serv.

897 Gryllus pennsylvanicus Burm.

898 **Long-winged mole cricket,** Gryllotalpa columbia Scudd.

Walking sticks, Phasmidae

899 **Walking stick,** Diapheromera femorata Say

Praying mantis or mule-killer, Mantidae

900 **Carolina mantis,** Stagmomantis carolina Linn.

Cockroaches, Blattidae

901 **Croton bug,** Phyllodromia germanica Steph.

902 **Cockroach,** Periplaneta orientalis Fabr.

903 **Wood cockroach,** Ischnoptera pennsylvanica DeG.

EARWIGS, Euplexoptera

904 **Earwig,** Forficula auricularia Linn.

PSOCIDS, Corrodentia

905 Psocus venosus Burm.

TERMITES, Isoptera

906 **Termites,** Termes flavipes Koll.

STONE FLIES, Plecoptera

907 Leuctra tenella Prov.

908 Leuctra *sp.*

909 Perla? tristis Hagen

910 Perla *sp.*

911 Pteronarcys ?regalis Newm.

DRAGON FLIES, Odonata

912 Leucorhinia intacta Hagen

913 Diplax rubicundula Say

914 Libellula pulchella Drury
915 L. basalis Say
916 Celithemis eponina Drury
917 Micrathyria berenice Drury
918 Plathemis 3-maculata DeG.
919 Tetragoneuria cynosura Say
920 Aeschna constricta Say
921 Boyeria vinosa Say
922 Cordulegaster erroneus Hagen
923 Enallagma hageni Walsh
924 Argia putrida Hagen
925 Lestes unguiculata Hagen
926 L. rectangularis Say
927 Calopteryx maculata Beauv.

MAY FLIES, Ephemerida

928 Ephemera ?simulans Walk.
929 Pentagenia vittigera Walsh
930 Callibaetis ferruginea Walsh

BRISTLETAILS, SPRINGTAILS, Thysanura

931 **Bristletail fishmoth,** Thermobia furnorum Rov.

PROTECTIVE MIMICRY (932-46)

Collection prepared and mounted by the Denton Bros., Wellesley Mass.

932 Danais tytia Gray (India). This insect is protected from the birds by an unpleasant odor or taste, and it is mimicked by 933, which is not distasteful to birds.

933 Papilio agestor Gray (India). This insect departs widely from the general appearance of most of its close relatives. Its resemblance to 932 undoubtedly protects it from molestation by birds.

934 Hebomoia glaucippe Linn. (China). Under surface; note its resemblance to the skeleton of a leaf.

935 Hypolimnas misippus Linn. (India). The female mimics 937, which is protected from birds by an unpleasant odor or taste. Compare with the male, 939.

936 Erebomorpha sp. (India). Note light and shadow effect, which is probably protective.

937 Danais chrysippus Linn. (India). Protected by an unpleasant odor or taste and mimicked by 935.

938 Hebomoia glaucippe Linn. (China). Upper surface; compare with 934.

939 Hypolimnas misippus Linn. (India). Male, not protected by mimicry; compare with female, 935.

940 **Monarch butterfly,** Anosia plexippus Linn. (North America). A native, very common species, having an unpleasant odor or taste and therefore not eaten by birds. It is mimicked by 941.

941 **Viceroy,** Basilarchia archippus Cram. (North America). Mimics 940 and differs greatly in general appearance from its close relatives.

942 Kallima inachis Boisd. (India). Leaf butterfly, under surface; note resemblance to brown leaves and also the imitation of fungous spots.

943 Kallima inachis Boisd. (India). Leaf butterfly. One showing upper surface of wings; compare with 942. And the other showing a butterfly in its resting position on a bare twig, it resembling a brown leaf very closely when in this position.

944 Attacus atlas Linn. (India). The tip of the wings resembles a cobra's head.

945 Catocala concumbens Walk. (North America). One specimen is spread, showing the highly colored hind wings and the other is mounted on a piece of bark in its resting position. Note how inconspicuous the latter is.

946 Caligo *sp.* (South America). The specimen is shown reversed, a position in which it resembles the head of an owl.

NEW YORK BEAUTIES (947-61)

This collection shows a few of our more beautiful native forms. Prepared and mounted by Denton Bros., Wellesley Mass.

947 **Red admiral,** Vanessa atalanta Linn. Under surface; compare with 950, showing the upper surface of the same insect.

948 **Mountain silver spot,** Argynnis atlantis Edw.

949 **Black swallowtail,** Papilio polyxenes Fabr. Under surface; compare with 952.

950 **Red admiral,** Vanessa atalanta Linn. Upper surface; compare with 947.

951 **Regal fritillary,** Speyeria idalia Drury.

952 **Black swallowtail,** Papilio polyxenes Fabr. Upper surface; compare with 949.

953 **Eight spotted forester,** Alypia 8-maculata Hübn. A common species about grapevine and Virginia creeper.

954 **Luna moth,** Tropaea luna Linn. A somewhat common moth.

955 **Imperial moth,** Basilona imperialis Drury. A rare moth in New York state.

956 Catocala nubilis, Hübn.

957 **Mourning cloak butterfly,** Euvanessa antiopa Linn. Very common, and in some sections of the state it is a serious pest of willow, poplar and elm trees.

958 **Triptogon modesta** Harris

959 **Thyreus abbotii** Swains

960 **Io moth,** Automeris io Fabr.

961 **Promethea moth,** Callosamia promethea Drury.

TECHNICAL COLLECTION (962-1021)

PREPARED BY C. S. BANKS

Cyanid bottles

962 Empty bottle

963 Bottle with cyanid

964 Bottle with cyanid and plaster

965 Bottle complete

966 Paper shavings in bottle

967 Chloroform bottle with brush

968 Collecting vials

969 Pill boxes

Butterfly papers

970 First fold

971 Second fold

972 Butterfly in position

973 Closed fold
974 Insect pins
975 Pin holder
976 Pinning block
977 Collecting net showing construction. For model *see* wing frame and wall.
978 Dip net, *see* model on wall
979 Mounts for small insects
980 Capsule mount
981 Glue for mounting insects[1]
982 Coleoptera mount
983 Hemiptera mount
984 Orthoptera mount
985 Locality and date labels

Mount by Denton method

986 Plaster cast
987 Mount complete

Alcoholic preparations

988 Bottle with label
989 Bottle with pin
990 Bottle on block
991 Pinning forceps
991a Forceps for handling insects
992 Sheet cork
993 Sheet peat
994 Relaxing device, *see* photograph in wing frame
995 Spreading apparatus
996 Spreading pins with handles
997 Strips used in spreading, mica, paper and glass
998 For spreading Microlepidoptera
999 Dr Lintner's device
1000 For spreading Hymenoptera
1001 For spreading Coleoptera

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1 Formula: Crush 75 to 100 grams of gelatin or clear glue, preferably the former, and put in a bottle with 100 cubic centimeters of commercial acetic acid (no. 8) and set in a warm place for three or more days, shaking occasionally. Then add 100 cc of water, 100 cc of 95% alcohol and 15 to 20 cc of glycerin. Operations may be hastened by heating the glue and acid in a water bath, but *great care* must be exercised if this is done.

For inflating larvae

1002 Larva on blowtube
1003 Drying ovens and tubes
1004 Wire mount on pin
1005 Wire mount complete
1006 Pocket lens
1007 Tripod lens

Insect pests of collections

1008 Anthrenus verbasci Linn.
1009 A. verbasci larva
1010 Attagenus piceus Oliv.
1011 Dermestes lardarius Linn.

Preventives and remedies for pests in collections

1012 Naphthalin cone
1013 Naphthalin ball
1014 Carbon bisulfid
1015 Verdigris on insect

Insect cases

1016 Green box
1017 Schmidt box
1018 Dr Lintner's Coleoptera box
1019 Corner Section insect case (United States national museum style)

Shipping devices

1020 Bottle in mailing tube
1021 Small box properly packed

FRAMED PHOTOGRAPHS

1022 "Bug house," where Dr Fitch did most of his work, Fitch's Point, Salem N. Y., photograph, 19 Sep. 1900.

1023 Asa Fitch M. D., entomologist State agricultural society, 1854-72.

1024 Residence of Dr Fitch, Fitch's Point, Salem N. Y., photograph, 19 Sep. 1900.

1025 Joseph Albert Lintner Ph.D., New York state entomologist, 1874-98.

1026 View of main portion of office of state entomologist, 1901.

Wing frames

1027 Photographs of private office of state entomologist, of the north wing and dark room in the general office, of trays of classified and unclassified insects. Table of correspondence during the past five years and a note on the state collection.

1028 Staff of the entomologic division of state museum. Table of Fitch reports, list of principal publications of state entomologist, and a note on additional publications.

1029 Blank forms used in office of state entomologist. Official paper, entomologic field station paper, official postal card, price list of publications, voluntary observer appointment blank, accession slip, receipt slip, locality and date label sheet, gummed labels, special printed labels, blank labels.

1030-31 Title pages of entomologic publications.

1032 Original figures from museum bulletins 26, 37 and a few others.

1033 Photographs of inflating, relaxing apparatus and work table in the general office.

1034 Pattern of butterfly net.

1035 Voluntary observer paper and list of voluntary observers for 1901.

1036 Map showing location of voluntary observers.

1037 Four anatomic plates, showing the structural details of Chloropisca variceps (fig. 7, 7th rep't), Phora agarici (pl. 2, 10th rep't), scorpion flies (pl. 4, 10th rep't) and of Diplosis cucumeris (pl. 2, 11th rep't).

1038 Miscellaneous plates as follows: upper austral life zone in New York (pl. 4, 11th rep't), cottonwood leaf beetle collecting machine (pl. 6, 11th rep't), illustrations of 17 year cicada (pl. 9 and 10, 12th rep't), and the great white leopard moth (pl. 1, 12th rep't).

1039 Three plates as follows: Work of forest tent-caterpillars in sugar orchard (fig. 4 in special paper on insects injurious to maple trees); forest tent-caterpillars on appletrees (pl. 15 and 16, 16th rep't).

1040 Miscellaneous plates as follows: gipsy moth (pl. 1, 16th rep't), palmer worm (pl. 2, 16th rep't), work of Scolytus rugulosus (pl. 14, 16th rep't), fumigating tent (pl. 13, 16th rep't).

1041 Shade tree pests as follows: maple and elm tree borers (pl. 7, 12th rep't), elm bark louse and work of elm leaf beetle (pl. 2, mus. bul. 27), spraying outfit in operation (fig. 3 in special paper on insects injurious to maple trees).

1042 Insects injurious to mapletrees: white marked tussock moth and forest tent-caterpillar (pl. 1 in special paper), leopard moth and maple sesian (pl. 2 in special paper), sugar maple borer, mapletree pruner and cottony mapletree scale insect (pl. 3 of special paper).

1043 Fruit tree and household pests: appletree tent-caterpillar (pl. 1), codling moth (pl. 3, 4), bedbug, red ant, larder beetle and croton bug (pl. 6). All the plates exhibited under this number were published in the transactions of the New York state agricultural society, 1899, and they illustrate a paper on injurious farm and household insects.

1044 Insecticides, results obtained with (pl. 4-7, 16th rep't).

1045 Insecticides, results obtained with (pl. 8, 9, 10 and 11, 16th rep't).

1046 Technical characters of scale insects, Aspidiotus perniciosus, A. ancylus, A. forbesi and A. ostreaeformis (pl. 11-15 of Museum bulletin 46).

1047 Aquatic insects, four colored plates representing some of the more important insects occurring in the Adirondacks (pl. 10-13 of Museum bulletin 47).

1048 Aquatic insects, two colored plates and two black and white plates illustrating methods of collecting and character of one locality (pl. 5, 6, 14 and 15 of Museum bulletin 47).

1049 Aquatic insects and their home (pl. 4, 9, 17 and 18 of Museum bulletin 47).

1050 Dragon flies and other insects (pl. 21, 23, 24 and 26 of Museum bulletin 47).

1051 Caddis flies and fish flies (pl. 27, 30-32 of Museum bulletin 47).

1052 Caddis flies and Diptera (pl. 33-36 of Museum bulletin 47).

PUBLICATIONS

Noxious, beneficial and other insects of the state of New York, reports 1-14, by Asa Fitch M. D., entomologist of the New York state agricultural society. Two volumes, half morocco.

Lintner entomologic publications, comprising Entomologic contributions 1-4; Report on the insect and other animal forms of Caledonia creek, New York; Report on the injurious insects of the year 1878; Insects of the clover plant; A new principle in protection from insect attack; Some injurious insects of Massachusetts; White grub of the May beetle; Our insect enemies and how to meet them; Late experiences with insects injurious to the orchard and garden, 1890; Report of the committee on entomology, 1891; Report of the committee on entomology, 1893; Report of the state entomologist for the year 1893. One volume, half morocco.

Injurious and other insects of the state of New York, reports 1-13, by J. A. Lintner, state entomologist. Four volumes, half morocco.

New York state museum bulletins

20 Elm leaf beetle in New York state, by E. P. Felt, acting state entomologist.

23 14th report of the state entomologist, by E. P. Felt, acting state entomologist.

24 Memorial of life and entomologic work of Joseph Albert Lintner Ph. D., state entomologist, 1874-98. Supplement to 14th report of the state entomologist, by E. P. Felt, state entomologist.

26 Collection, preservation and distribution of New York insects, by E. P. Felt, state entomologist.

27 Shade tree pests in New York state, by E. P. Felt, state entomologist.

31 15th report of the state entomologist, by E. P. Felt, state entomologist.

36 16th report of the state entomologist, by E. P. Felt, state entomologist.

37 Illustrated descriptive catalogue of some of the more important injurious and beneficial insects of New York state, by E. P. Felt, state entomologist. All the bulletins except no. 36 were bound in one half morocco volume.

EXPLANATION OF PLATES

PLATE 1

Hessian fly Cecidomyia destructor Say

A wheat plant showing an uninjured stalk at the left and one infested with the Hessian fly at the right. The leaves of the latter are dwarfed and withered and the stem is swollen at three points near the ground where the "flaxseeds" are located between the leaf sheath and the stem.

a Egg of Hessian fly greatly enlarged as are all figures except *e* and *h*

b Larva, its natural size indicated by the line beside it

c Puparium, "flaxseed" or pupal case

d Pupa

e Adult female ovipositing on leaf, natural size

f Adult female, very much enlarged

g Male, very much enlarged

h "Faxseeds" in position between leaf sheath and stem

i Parasite, Merisus destructor, male, much enlarged

All from Packard, U. S. ent. com. 3d rep't, *b* drawn by Dr Riley, *d* and *f* by Mr Burgess, *a*, *g*, *c* and *i* by Prof. Packard.

PLATE 2

European willow gall midge

Rhabdophaga salicis Schrk.

FIG.

1 Breast bone of larva

2 Dorsal view of pupal case, showing setaceous processes

3 Distal segment of tarsus, showing claws and pulvillus from side

FIG.

4 Pulvillus

5 Two segments of antenna of male

6 Two segments of antenna of female. All very greatly enlarged

PLATE 3

Leopard moth

Zeuzera pyrina Linn.

1 Larva and castings

2 Empty pupal case

3 Female moth at rest. All on a badly bored piece of wood

PLATE 4

1 Gall of Rhabdophaga salicis Schrk. on European willow

2 Lecanium nigrofasciatum (After Pergande, U. S. dep't agric. div. ent. Bul. 18 new series '98. p. 27)

3 Rose scale insect, Aulacaspis rosae Sandb., on blackberry, enlarged

4 Male, female and young scale, very much enlarged

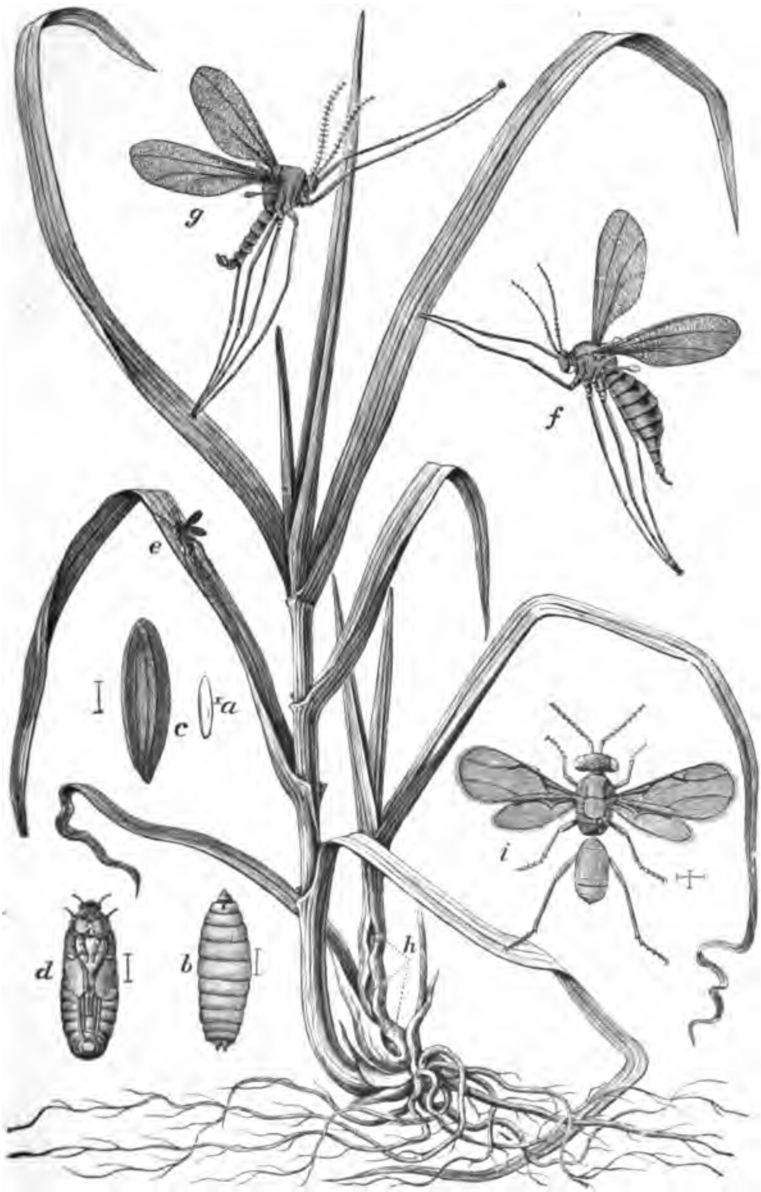
5 Birch leaf Bucculatrix, Bucculatrix canadensisella: *a* skeletonized leaf; *b* molting cocoon; *c* larva; *d* head of larva; *e* anal segments of larva; *f* same of pupa; *g* cocoon with extruded pupa skin; *h* moth—all enlarged. (From *Insect life*)

PLATE 5

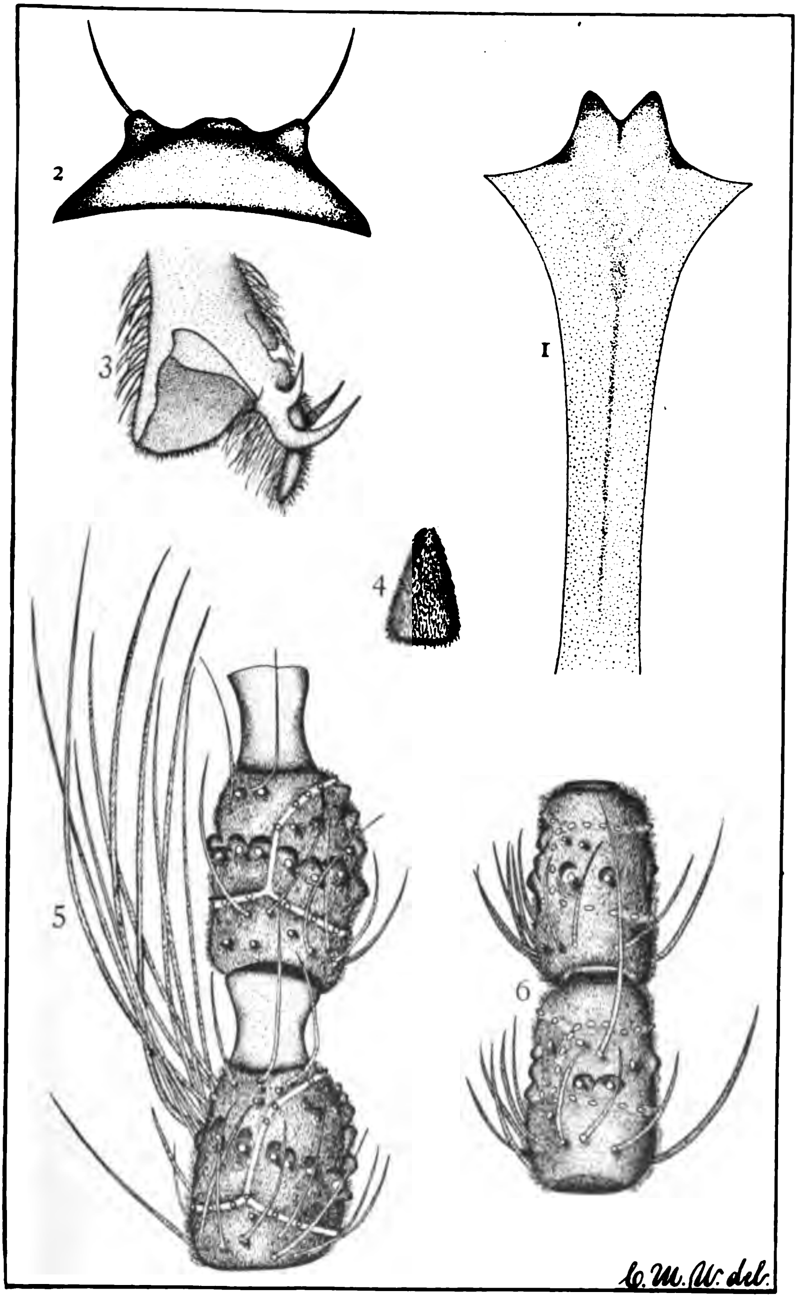
General view of experimental orchard showing thrifty appearance of young trees infested with San José scale, showing how the pest has been controlled by spraying. Photo 8 Oct. 1901

PLATE 6

Young orchard in bad condition on account of San José scale and yet it became infested later than the orchard represented on pl. 5 but prior to date had not been sprayed. Photo 8 Oct. 1901.



Hessian fly



European willow gall midge

Plate 3

Leopard moth

Plate 4

1

4

2

5

3

Photo 8 Oct. 1901

Experimental orchard, showing value of spraying, compare with pl. 6

Unsprayed, San José scale infested orchard, compare with pl. 5

Photo 8 Oct. 1901

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New York State Museum

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New York State Museum

FREDERICK J. H. MERRILL Director
CHARLES H. PECK State Botanist

Bulletin 54

BOTANY 5

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BY

CHARLES H. PECK M.A.

ALBANY

UNIVERSITY OF THE STATE OF NEW YORK

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BOTANY 5

REPORT OF THE STATE BOTANIST 1901

To the Regents of the University of the State of New York

I have the honor of submitting to you the report of work done in the botanical department of the state museum during the year 1901.

Specimens of plants for the herbarium have been collected in the counties of Albany, Essex, Franklin, Rensselaer, Warren and Washington. Specimens have been received from correspondents, either as contributions or for identification, that were collected in the counties of Albany, Columbia, Chautauqua, Essex, Franklin, Herkimer, Monroe, Oneida, Onondaga, Ontario, Schoharie, St Lawrence, Warren and Washington. The number of species of which specimens have been collected and added to the herbarium is 374. Of these, 57 were not before represented in it. Of the newly represented species, 37 are found in the collections of the botanist, 20 in those of his correspondents, and of the whole number, 16 are considered new to science and are described as such in the following pages. All of these are fungi and with one exception belong to the collections of the botanist. Specimens of the remaining 317 species make the representation of these species more complete and satisfactory. Of these, 282 belong to the collections of the botanist and 35 to those of his correspondents. A list of the names of the added species is marked A.

The number of those who have contributed specimens for the herbarium or for identification is 34. Of these, 14 have sent extralimital specimens. A list of the names of the contributors and of their respective contributions is marked B.

A record of species not before reported, with notes concerning them, time and place of collecting the specimens and descriptions of new species is marked C.

A part of the report containing remarks on previously recorded species and descriptions of new varieties is marked D.

The investigation of our edible species of mushrooms has been continued. Of those whose edible qualities have been tried, 11 species have been thought worthy of addition to the list of edible fungi. Descriptions of these may be found in a part of the report marked E. Colored figures of these and also of seven of the new species have been prepared.

At the request of the director of the state museum a botanical exhibit was prepared for the Pan-American exposition at Buffalo. But little time was given for the preparation of this exhibit, yet specimens were selected from material on hand that should fairly represent the herbarium, and the principal divisions and groups of plants that constitute our state flora. Seed-bearing or flowering plants, ferns and fern allies, mosses, lichens, marine algae and fungi were all represented by specimens of one or more species. So far as possible, specimens were selected that have more or less economic importance and therefore popular interest, because of some utility of the plants themselves or of some of their products, or because of some injurious character either as troublesome weeds or harmful or destructive parasites or saprophytes. Among the parasitic fungi the smuts were represented by several species because they are so injurious to our crops of cereals. Among saprophytic fungi those destructive to wood and also those valued for their edibility were specially represented. The specimens placed on exhibition have been safely returned to the herbarium, but those of the seed-bearing plants have suffered a little deterioration in appearance because of their long exposure to strong light. Their green color has faded.

The herbarium has been moved from the capitol to geological hall where it has a place far more suitable, more commodious, better lighted, more convenient for botanical work and more accessible to the public. Thanks are due to all who have aided in bringing about this change. It is very desirable that it may not again be necessary to store any part of it where it may not

be under the immediate control of the botanist in charge. Such a condition of things, as in the present case, is very likely to result in injury to or loss of specimens. Some of the stored specimens were destroyed by insects, some by moisture, having been placed apparently where they became wet by a leak in the roof. A glass case containing puff balls was broken and its contents spoiled or destroyed, and two boxes, one containing specimens and the other mushroom models, could not be found.

The room in geological hall which has been assigned to the botanical department is on the second floor in the southern extension of the building. It is divided into two parts, the front part being used as a show room and containing the sections of the trunks of our trees arranged in wall cases, and photographs and thin sections of the wood of the trees exhibited in swinging frames supported by upright standards. It is expected also to contain table cases in which will be exhibited specimens of our edible and poisonous mushrooms and other plants or parts or products of plants that may have such importance or economic value as to be of special public interest. The rear part of the room contains the office of the botanist, the library, the herbarium and duplicate specimens together with specimens of extralimital species. It will also be used in part as a botanical workroom.

Several species of thorn recently described, having been reported as occurring at Crown Point, that locality was visited late in May with the purpose of collecting flowering specimens for the herbarium. The thorn shrubs and small trees were found in abundance along the northern and western shores of the promontory, and about the ruins of the old fort. Their leaves were generally badly infested by plant lice, a condition which it is said is repeated every year. The cockspur thorn is the prevailing species and was in better condition than the others. The large fruited thorn, Crataegus punctata, the long spined thorn, C. macracantha, the Champlain thorn, C. champlainensis, Pringle's thorn, C. pringlei, and the pruinose fruited thorn, C. pruinosa, were found there.

The last three are additions to the previously known species of our flora. The red seeded dandelion, Taraxacum ery-

throspermum, and the flickweed, Sophia sophia, were also found there and are additions to our flora.

In July a trip was made to North Elba, specially to visit Mt Clinton and the southeastern cliffs of Mt Wallface. Mt Clinton is the most southern of the three prominent peaks in the Mt McIntyre range and so far as known to me had never been visited by any botanist. Its open summit was found to be less extensive than had been anticipated and it furnished no additions to our flora. The alpine juniper, Juniperus communis alpina, was found there in greater abundance than on the higher summit of Mt McIntyre and was fruiting sparingly. The dwarf paper birch, Betula papyracea minor, was also abundant and fruiting freely though only 2 or 3 feet high. The arbor vitae, Thuja occidentalis, in a dwarf irregular form ascends to the open summit of the mountain.

On the southeastern cliffs of Mt Wallface the twisted whitlow-grass, Draba incana arabisans, was found in abundance in fruiting condition. It probably flowers here in June. Fine fruiting specimens of the spiked wood-rush were associated with it. This had been previously discovered on the top of Mt Wallface. This mountain is at present the only locality known to me in our state where these two plants are found.

In August, Bolton and the surrounding region on the west shore of Lake George was explored botanically and found to be prolific in fungi. Showers had been frequent and weather conditions were favorable to the growth of mushrooms. In this visit and a subsequent one in September, which was extended northward to Hague, many species of fungi were added to the list of New York plants and several were tried and found worthy of addition to our list of edible mushrooms.

Respectfully submitted

CHARLES H. PECK

State botanist

Albany, 17 Dec. 1901

A

PLANTS ADDED TO THE HERBARIUM

New to the herbarium

Conringia orientalis (*L.*) *Dumort.*
Geum vernum *T. & G.*
Crataegus champlainensis *Sarg.*
C. pringlei *Sarg.*
C. holmesiana *Ashe*
C. pruinosa *Wend.*
Vernonia gigantea (*Walt.*) *Britton*
Antennaria parl. arnoglossa *Fern.*
Centaurea jacea *L.*
Lactuca morssii *Robins.*
Taraxacum erythrospermum *Andrz.*
Hedeoma hispida *Pursh*
Panicularia laxa *Scribn.*
Mylia anomala (*Hook.*) *S. F. Gray*
Scapania irrigua (*Nees*) *Dumort.*
Cetraria aurescens *Tuckm.*
Stereocaulon denudatum *Fl.*
Endocarpon fluviatile *DC.*
Pannaria leucosticta *Tuckm.*
Lepiota adnatifolia *Pk.*
Tricholoma rimosum *Pk.*
Clitocybe regularis *Pk.*
C. subconcava *Pk.*
Pleurotus minutus *Pk.*
Lactarius foetidus *Pk.*
Hygrophorus glutinosus *Pk.*
Volvaria speciosa *Fr.*
V. hypopithys *Fr.*
Cortinarius submarginalis *Pk.*
C. obliquus *Pk.*
Cortinarius violaceo-cinereus (*Pers.*) *Fr.*
Boletus multipunctus *Pk.*
Fistulina pallida *B. & R.*
Poria myceliosa *Pk.*
Hydnum umbilicatum *Pk.*
Thelephora exigua *Pk.*
T. multipartita *Schw.*
Corticium portentosum *B. & C.*
C. arachnoideum *Berk.*
Peniophora parasitica *Burt*
P. affinis *Burt*
Asterostroma bicolor *E. & E.*
Clavaria bicolor *Pk.*
Phallogaster saccatus *Morg.*
Cyathus lesueurii *Tul.*
Didymium fairmani *Sacc.*
Physarella multiplicata *Macb.*
Empusa grylli *Fresen.*
Marsonia pyriformis (*Riess*) *Sacc.*
Septoria polygonina *Thum.*
Chalara paradoxa (*Seynes*) *Sacc.*
Colletotrichum antirrhini *Stewart*
C. rudbeckii *Pk.*
Helvella adhaerens *Pk.*
Lachnella corticalis (*Pers.*) *Fr.*
Anthostoma dryophilum (*Curr.*) *Sacc.*
Mycenastrum spinulosum *Pk.*

Not new to the herbarium

Clematis virginiana *L.*
Trollius laxus *Salisb.*
Ranunculus bulbosus *L.*
Hepatica acuta (*Pursh*) *Britton*
Berberis vulgaris *L.*
Podophyllum peltatum *L.*
Castalia tuberosa (*Paine*) *Greene*
Arabis hirsuta (*L.*) *Scop.*
Dentaria laciniata *Muhl.*
D. maxima *Nutt.*
Draba incana arabisans *Mx.*
Xanthoxylum americanum (*Mill.*)
Rhus copallina *L.*
Vaccaria vaccaria (*L.*) *Britton*
Lychnis flos-cuculli *L.*
Malva sylvestris *L.*

Amorpha fruticosa *L.*
Meibomia paniculata (*L.*) *Kuntze*
Vicia tetrasperma (*L.*) *Moench*
Cassia marylandica *L.*
Polygala viridescens *L.*
Spiraea salic. latifolia *Ait.*
Potentilla arguta *Pursh*
Rubus strigosus *Mx.*
Crataegus macracantha *Lodd.*
C. modesta *Sarg.*
Ludwigia alternifolia *L.*
Chamaenerion angustifolium (*L.*) *Scop.*
Onagra biennis (*L.*) *Scop.*
Ilex verticillata (*L.*) *Gray*
Viburnum pauciflorum *Pylaie*
Galium verum *L.*
Valerianella chenopodifolia (*Pursh*) *DC.*
Aster vimineus *Lam.*
A. lateriflorus (*L.*) *Britton*
Solidago juncea *Ait.*
S. caesia *L.*
Galinsoga parviflora *Cav.*
Antennaria neodioica *Greene*
Lactuca spicata (*Lam.*) *Hitch.*
L. spi. integrifolia (*Gr.*) *Hitch.*
Onopordon acanthium *L.*
Rudbeckia triloba *L.*
Gaylussacia resinosa (*Ait.*) *T. & G.*
Kalmia angustifolia *L.*
Lysimachia terrestris (*L.*) *B. S. P.*
Conopholis americana (*L.*) *Wallr.*
Dianthera americana *L.*
Cuscuta epithymum *Murr.*
Scrophularia leporella *Bickn.*
Pentstemon pentstemon (*L.*) *Britton*
Solanum carolinense *L.*
Tetragonanthus deflexus (*Sm.*) *Kuntze*
Monarda fistulosa *L.*
Euphorbia platyphylla *L.*
Myosotis verna *Nutt.*
Chenopodium anthelminticum *L.*
Betula pap. minor *Tuckm.*
Hickoria minima (*Marsh.*) *Britton*
Juniperus com. alpina *Gaud.*
Potamogeton lonchites *Tuckm.*
P. obtusifolius *M. & K.*
Gyrostachys gracilis (*Bigel.*) *Kuntze*
G. romanzoffiana (*Cham.*) *MacM.*
Streptopus amplexifolius (*L.*) *DC.*
Clintonia borealis (*Ait.*) *Raf.*
Juncoides spicatum (*L.*) *Kuntze*
Eleocharis ovata (*Roth*) *R. & S.*
E. diandra *Wright*
Eriophorum virginicum *L.*
Scirpus peckii *Britton*
S. rubrotinctus *Fern.*
S. atrocinctus *Fern.*
Rhynchospora glomerata (*L.*) *Vahl*
Fimbristylis autumnalis (*L.*) *R. & S.*
Hemicarpha micrantha (*Vahl*) *Britton*
Panicum dichotomum *L.*
Agrostis alba *L.*
Poa flava *L.*
Panicularia canadensis (*Mx.*) *Kuntze*
Muhlenbergia mexicana (*L.*) *Trin.*
Homalocenchrus oryzoides (*L.*) *Poll.*
Dryopteris noveboracensis (*L.*) *Gray*
D. spin. dilatata (*Hoffm.*) *Underw.*
Woodsia obtusa *Torr.*
Botrychium lanceolatum *Angst.*
B. matricariaefolium *A. Br.*
B. obliquum *Muhl.*
B. dissectum *Spreng.*
Equisetum lit. gracile *Milde*
Lycopodium annotinum *L.*
L. tristachyum *Pursh*
Sphagnum pylaesii *Brid.*
Dicranum elongatum *Schwaegr.*
Tetraphis pellucida *Hedw.*
Hedwigia ciliata *Ehrh.*
Polytrichum strictum *Banks.*
Riccia fluitans *L.*
Marchantia polymorpha *L.*
Theloschistes parietinus (*L.*) *Norm.*

Cetraria islandica (*L.*) *Ach.*
C. nivalis *Ach.*
Baeomyces aeruginosus (*Scop.*) *DC.*
Stereocaulon paschale (*L.*) *Fr.*
Cladonia deformis (*L.*) *Hoffm.*
C. cristatella *Tuckm.*
C. cornucopioides (*L.*) *Fr.*
C. uncialis (*L.*) *Fr.*
C. rangiferina (*L.*) *Hoffm.*
Calicium subtile *Pers.*
Amanita phalloides *Fr.*
A. frostiana *Pk.*
A. spreta *Pk.*
A. musc. formosa (*G. & R.*) *Fr.*
Amanitopsis volvata (*Pk.*) *Sacc.*
A. vaginata (*Bull.*) *Roze*
Lepiota friesii *Lasch.*
L. acutesquamosa *Weinm.*
L. felina *Pers.*
L. granulosa *Batsch*
L. rugosoreticulata *Lorin.*
L. cristatella *Pk.*
L. illinita *Fr.*
Tricholoma russula (*Schaeff.*) *Fr.*
T. rutilans (*Schaeff.*) *Fr.*
T. variegatum (*Scop.*) *Fr.*
T. tricolor *Pk.*
T. peckii *Howe*
T. fallax *Pk.*
T. alboflavidum *Pk.*
T. fuligineum *Pk.*
T. album (*Schaeff.*) *Fr.*
Clitocybe anisaria *Pk.*
C. dealbata *Sow.*
C. infundibuliformis (*Schaeff.*)
C. adirondackensis *Pk.*
C. laccata (*Scop.*) *Fr.*
C. ochropurpurea *Berk.*
Collybia radicata (*Relh.*) *Fr.*
C. platyphylla *Fr.*
C. maculata (*A. & S.*) *Fr.*
C. butyracea (*Bull.*) *Fr.*
C. dryophila (*Bull.*) *Fr.*
C. esculentoides *Pk.*
C. velutipes (*Curt.*) *Fr.*
Collybia confluens (*Pers.*) *Fr.*
Mycena immaculata *Pk.*
M. galericulata (*Scop.*) *Fr.*
M. pseudopura *Cke.*
Omphalia umbellifera (*L.*) *Fr.*
O. atratoides *Pk.*
O. fibula (*Bull.*) *Fr.*
O. swartzii *Fr.*
O. camp. sparsa *Pk.*
Hygrophorus laurae *Morg.*
H. pratensis (*Pers.*) *Fr.*
H. chlorophanus *Fr.*
H. nitidus *B. & C.*
Lactarius cilicioides *Fr.*
L. indigo (*Schw.*) *Fr.*
L. chelidonium *Pk.*
L. subpurpureus *Pk.*
L. aquifluus *Pk.*
L. theiogalus (*Bull.*) *Fr.*
L. chrysorrheus *Fr.*
L. pyrogalus (*Bull.*) *Fr.*
L. alpinus *Pk.*
L. camphoratus (*Bull.*) *Fr.*
Russula decolorans *Fr.*
R. rugulosa *Pk.*
Cantharellus floccosus *Schw.*
C. umbonatus *Fr.*
C. lutescens *Fr.*
Nyctalis asterophora *Fr.*
Marasmius peronatus *Fr.*
M. subnudus (*Ellis*) *Pk.*
M. semihirtipes *Pk.*
M. spongiosus *B. & C.*
M. impudicus *Fr.*
Lentinus ursinus *Fr.*
L. lepideus *Fr.*
Panus stipticus (*Bull.*) *Fr.*
Lenzites bet. radiatus *Pk.*
L. sepiaria *Fr.*
L. vialis *Pk.*
Entoloma sinuatum *Fr.*
E. sericeum (*Bull.*) *Fr.*
Clitopilus micropus *Pk.*
C. abortivus *B. & C.*
Pholiota squarrosa *Mull.*

Pholiota praecox *Pers.*
Inocybe infelix *Pk.*
I. geophylla *Sow.*
Stropharia aeruginosa (*Curt.*) *Fr.*
Hypholoma incertum *Pk.*
H. aggre. sericeum *Pk.*
Cortinarius berlesianus *Sacc.*
C. sublateritius *Pk.*
Boletinus pictus *Pk.*
Boletus bicolor *Pk.*
B. chrys. deformatus *Pk.*
B. pallidus *Frost*
B. variipes *Pk.*
B. eximius *Pk.*
B. ornatipes *Pk.*
B. felleus *Bull.*
B. cyanescens *Bull.*
Fistulina hepatica *Fr.*
Polyporus ovinus (*Schaeff.*) *Fr.*
P. poripes *Fr.*
P. confluens (*A. & S.*) *Fr.*
P. resinosus (*Schrad.*) *Fr.*
P. chioneus *Fr.*
P. adustus (*Willd.*) *Fr.*
P. gilvus *Schw.*
Gloeoporus conchoides *Mont.*
Fomes lucidus (*Leys*) *Fr.*
F. applanatus (*Pers.*) *Wallr.*
F. fomentarius (*L.*) *Fr.*
F. roseus (*A. & S.*) *Fr.*
F. conchatus (*Pers.*) *Fr.*
Polystictus radiatus *Fr.*
P. hirsutus *Fr.*
P. pergamenus *Fr.*
P. pseudopergamenus (*Thum.*)
Poria subacida *Pk.*
P. mutans *Pk.*
Trametes trogii *Berk.*
T. sepium *Berk.*
T. serialis *Fr.*
T. cinnabarina (*Jacq.*) *Fr.*
Daedalea confragosa *Pers.*
D. unicolor *Fr.*
Cyclomyces greenii *Berk.*
Caldesiella ferruginosa (*Fr.*) *Sacc.*
Hydnum scrobiculatum *Fr.*
H. zonatum *Batsch*
H. vellereum *Pk.*
H. septentrionale *Fr.*
Irpex lacteus *Fr.*
I. ambiguus *Pk.*
Mucronella min. conferta *Pk.*
Craterellus lutescens (*Pers.*) *Fr.*
C. cornucopioides (*L.*) *Pers.*
C. cantharellus (*Schw.*) *Fr.*
Thelephora caryophyllea (*Schaeff.*) *Pers.*
Stereum fasciatum *Schw.*
S. complicatum *Fr.*
Hymenochaete tabacina (*Sow.*) *Lev.*
Corticium evolvens *Fr.*
C. alutaceum (*Schrad.*)
C. investiens (*Schw.*)
C. lilacino-fuscum *B. & C.*
Guepinia spathularia (*Schw.*) *Fr.*
Clavaria flava *Schaeff.*
C. cristata *Pers.*
C. gracilis *Pers.*
C. pyxidata *Pers.*
C. circinans *Pk.*
C. pinophila *Pk.*
C. aurea *Schaeff.*
C. pulchra *Pk.*
Physalacria inflata (*Schw.*) *Pk.*
Phallus ravenelii *B. & C.*
Cyathus striatus (*Huds.*) *Hoffm.*
Bovista plumbea *Pers.*
Scleroderma vulgare *Hornem.*
S. verrucosum (*Bull.*) *Pers.*
Calvatia cyathiformis (*Bosc.*)
Lycoperdon gemmatum *Batsch*
L. pyriforme *Schaeff.*
L. subincarnatum *Pk.*
L. cruciatum *Rost.*
L. frostii *Pk.*
L. curtisii *Berk.*
Fuligo ovata (*Schaeff.*) *Macb.*
Tubifera ferruginosa (*Batsch*) *Macb.*
Reticularia lycoperdon *Bull.*
Spumaria alba (*Bull.*) *DC.*

Physarum compressum *A. & S.*
Tilmadoche viridis (*Bull.*) *Sacc.*
Diachaea leucopoda (*Bull.*) *R.*
D. subsessilis *Pk.*
Didymium melanospermum (*Pers.*) *Macb.*
Stemonitis fusca (*Roth*) *R.*
S. smithii *Macb.*
Comatricha stemonitis (*Scop.*) *Sheldon*
C. aequalis *Pk.*
Dictydium cancellatum (*Batsch*)
Lachnobolus globosus (*Schw.*) *R.*
Arcyria cinerea (*Bull.*) *Pers.*
A. denudata (*L.*) *Sheldon*
A. nutans (*Bull.*) *Grev.*
Hemitrichia vesparium (*Batsch*)
Trichia favoginea (*Batsch*) *Pers.*
Uredo polypodii (*Pers.*) *DC.*
Coleosporium solidaginis (*Schw.*)
Melampsora farinosa (*Pers.*) *Schroet.*
Ustilago zeae (*Beckm.*) *Ung.*
U. utriculosa (*Nees*) *Tul.*
U. anomala *Kze.*
Septoria irregularis *Pk.*
S. acerina *Pk.*
Pilacre faginea (*Fr.*) *B. & Br.*
Monilia fructigena *Pers.*
Ramularia tulasnei *Sacc.*
Glomerularia corni *Pk.*
Spathularia crispa *Pk.*
S. clavata (*Schaeff.*)
Leotia lubrica (*Scop.*) *Fr.*
Helvella infula *Schaeff.*
H. gracilis *Pk.*
Vibrissea truncorum (*A. & S.*)
Lachnella citrina *Pk.*
Dasyscypha bicolor (*Bull.*) *Fckl.*
Phyllachora pteridis (*Reb.*) *Fckl.*
Rhytisma acerinum (*Pers.*) *Fr.*
Hypoxylon perforatum *Schw.*

B

CONTRIBUTORS AND THEIR CONTRIBUTIONS

Mrs N. L. Britton, New York

Gymnostomum rupestre *Schwaegr.*
Seligeria doniana (*Sw.*) *All.*
Dicranella heteromalla *Schp.*
Dicranum fulvum *Hook.*
D. flagellare *Hedw.*
Didymodon rubellus *B. & S.*
D. riparius *Aust.*
Grimmia apocarpa *Hedw.*
Hedwigia ciliata *Ehrh.*
Amphoridium lapponicum *Schp.*
Drummondia clavellata *Hook.*
Ulota hutchinsiae *Schp.*
Tetraphis pellucida *Hedw.*
Bartramia pomiformis *Hedw.*
Philonotis fontana *Brid.*
Bryum roseum *Schreb.*
Webera albicans *Schp.*
Mnium affine *Bland.*
M. punctatum *Hedw.*
M. elatum *B. & S.*
M. spinulosum *B. & S.*
Pogonatum alpinum *Roehl.*
Diphyscium foliosum *Mohr.*
Fontinalis antip. gigantea *Sull.*
Leptodon trich. immersus *Sull.*
Homalia jamesii *Schp.*
Myurella careyana *Sull.*
Anomodon rostratus *Schp.*
A. attenuatus *Hueben.*
A. viticulosus *H. & T.*
Cylindrothecium cladorrhizans *Schp.*
Climacium americanum *Brid.*
Hypnum delicatulum *L.*
H. rusciforme *Weis.*
H. pulchellum *Dicks.*
H. reptile *Mx.*
H. imponens *Hedw.*
H. haldanianum *Grev.*
H. eugyrium *Schp.*
H. brevirostre *Ehrh.*
H. triquetrum *L.*
H. radicale *Bv.*
Cetraria islandica (*L.*) *Ach.*
Mitrula phalloides (*Bull.*) *Chev.*

Mrs M. A. Knickerbocker, Douglaston

Centaurea jacea *L.*
Galium verum *L.*

Miss Emma S. Thomas, Schoharie

Lepiota acutesquamosa *Weinm.*
Lycoperdon pyriforme *Schaeff.*

Miss Harriet A. Edwards, Port Henry

Botrychium virginianum (*L.*) *Sw.*

Mrs G. M. Dallas, Philadelphia Pa.

Thelephora caespitulans *Schw.*

Mrs T. B. Bishop, San Francisco Cal.

Xerophyllum tenax *Nutt.*

Miss M. L. Overacker, Syracuse

Podophyllum peltatum *L.*
Viola striata *Ait.*
Crepis virens *L.*
Lythrum salicaria *L.*
Stropharia aeruginosa (*Curt.*)

Miss N. L. Marshall, New York

Volvaria hypopithys *Fr.*

E. A. Burt, Middlebury Vt.

Poria subtilis (*Schrad.*) *Bres.*
Corticium sulphureum *Pers.*
Peniophora parasitica *Burt*
Asterostroma bicolor *E. & E.*
Dacryomyces deliquescens (*Bull.*) *Dub.*
Grandinia granulosa *Fr.*

M. L. Fernald, Cambridge Mass.

Carex atlantica *Bailey*
Carex elachycarpa *Fern.*

B. D. Gilbert, Clayville

Botrychium dissectum *Spreng.*
Lycopodium tristachyum *Pursh*

C. G. Lloyd, Cincinnati O.

Calostoma cinnabarinum *Desv.*
Geaster coliformis (*Dicks.*) *Pers.*
Lycoperdon glabellum *Pk.*

G. B. Fessenden, Boston Mass.

Pluteolus coprophilus *Pk.*

F. C. Stewart, Geneva

Colletotrichum antirrhini *Stewart*
C. rudbeckiae *Pk.*
Marsonia pyriformis (*Riess*) *Sacc.*

S. H. Burnham, Vaughns

Hepatica acuta (*Pursh*) *Britton*

E. B. Sterling, Trenton N. J.

Phallogaster saccatus *Morg.*
Morchella angusticeps *Pk.*

J. J. Hastings, Albany

Clitocybe multiceps *Pk.*
Pholiota praecox *Pers.*
Hypholoma incertum *Pk.*

E. B. Conger, Peninsula O.
Erythronium albidum *Nutt.*

H. L. Clapp, Roxbury Mass.
Hygrophorus ventricosus *B. & Br.*

J. B. Ellis, Newfield N. J.
Phyllosticta limitata fructigena *Ellis*

F. S. Boughton, Pittsford

Polyporus morgani *Frost*
Lycoperdon frostii *Pk.*
Fistulina pallida *B. & R.*

A. P. Hitchcock, New Lebanon
Boletus felleus *Bull.*

Rev. J. M. Bates, Callaway Neb.

Tylostoma campestre *Morg.*
T. poculatum *White*
Catastoma subterraneum *Pk.*
Geaster campestris *Morg.*

Simon Davis, Boston Mass.

Armillaria nardosmia *Ellis*
Hygrophorus sordidus *Pk.*
H. pallidus *Pk.*
Russula ventricosipes *Pk.*
Rhizopogon rubescens *Tul.*
Scleroderma verrucosum *(Bull.) Pers.*

W. F. Badè, Bethlehem Pa.
Anychia dichotoma *Mx.*

C. S. Banks, Manila, Philippine islands

Aquilegia canadensis *L.*
Trifolium repens *L.*
Potentilla canadensis *L.*
Geum rivale *L.*
Hamamelis virginiana *L.*
Zizia aurea (*L.*) *Koch*
Rumex acetosella *L.*
Cypripedium hirsutum *Mill.*
Asarum canadense *L.*
Eriophorum polystachyon *L.*
Carex sterilis *Willd.*
Onoclea sensibilis *L.*
Adiantum pedatum *L.*
Asplenium platyneuron *L.*
Dryopteris acrostichoides (*Mx.*)

F. J. Braendle, Washington D. C.

Polyporus lacteus *Fr.*
Clavaria grandis *Pk.*

J. V. Haberer, Utica

Ranunculus bulbosus *L.*
Trollius laxus *Salisb.*
Arabis hirsuta (*L.*) *Scop.*
A. laevigata (*Muhl.*) *Poir.*
Conringia orientalis (*L.*) *Dumort.*
Dentaria laciniata *Muhl.*
D. maxima *Nutt.*
Vaccaria vaccaria (*L.*) *Britton*
Geum vernum *T. & G.*
Opulaster opulifolius (*L.*) *Kuntze*
Polygala viridescens *L.*
Floerkea proserpinacoides *Willd.*
Sarothra gentianoides *L.*
Galium mollugo *L.*
Valerianella chenopodifolia (*Pursh*) *DC.*
Vernonia gigantea (*Walt.*)
Hieracium praealtum *Vill.*

Rhododendron maximum *L.*
Lysimachia quadrifolia *L.*
Tetragonanthus deflexus *(Sm.) Kuntze*
Monarda fistulosa *L.*
Hedeoma hispida *Pursh*
Koellia virginiana *(L.) MacM.*
Pentstemon pentstemon *(L.) Britton*
Dianthera americana *L.*
Scirpus sylvaticus *L.*
S. rubrotinctus *Fern.*
Eriophorum virg. album *Gray*
Rhynchospora glomerata *(L.) Vahl*
Hemicarpha micrantha *(Vahl) Britton*
Fimbristylis autumnalis *(L.) R. & S.*
Eleocharis diandra *Wright*
E. vigens *(Bailey)*
Botrychium lanceolatum *Angst.*
B. matricariaefolium *A. Br.*
B. obliquum *Muhl.*
B. tern. intermedium *Eaton*
Equisetum lit. gracile *Milde*
Lycopodium inundatum *L.*

H. H. Hume, Lake City Fla.

Exobasidium peckii *Halst.*
Entomosporium maculatum *Lev.*
Pyricularia grisea *(Cke.) Sacc.*
Sorosporium everhartii *E. & G.*
Puccinia graminis *Pers.*
P. fuirenae *Cke.*
P. hydrocotyles *(Mont.) Cke.*
P. hieracii *(Schum.) Mart.*
Ravenelia glanduliformis *B. & C.*
Uromyces elegans *(B. & C.) Lagh.*
U. caladii *(Schw.) Farl.*
U. spermacoces *(Schw.) Thum.*
U. graminicola *Burrill*
U. hedysari paniculati *(Schw.)*
Ustilago floridana *E. & E.*
Caeoma nitens *Schw.*
Scolecotrichum caricae *E. & E.*
Thecapsora vacciniorum *B. & C.*
Phyllosticta nerii *West.*
P. roberti *B. & J.*
P. phaseolina *Sacc.*
P. ipomaeae *E. & K.*
P. phomiformis *Sacc.*
P. vaccinii *Earle*
P. caryae *Pk.*
P. curtisii *(Sacc.) E. & E.*
P. livida *E. & E.*
P. acericola *C. & E.*
Pestalozzia palmarum *Cke.*
P. crataegi *E. & E.*
Septoria oenotherae *West.*
S. lycopersici *Speg.*
S. drummondii *E. & E.*
Graphiola phoenicis *(Moug.) Poit.*
Macrosporium asimini *Hume*
M. solani *E. & M.*
Helminthosporium ravenelii *B. & C.*
Peronospora gonolobii *Lagh.*
Plasmopara cubensis *(B. & C.) Hume*
Cystopus candidus *(Pers.) Lev.*
C. ipomaeae-panduratae *(Schw.)*
Exoascus varius *Atk.*
Cercospora petersii *(B. & C.) Atk.*
C. flagellaris *E. & M.*
C. hamamelidis *E. & E.*
C. phyllitidis *Hume*
C. hibisci *T. & E.*
C. vignae *E. & E.*
C. callicarpae *Cke.*
C. hydrocotyles *E. & E.*
C. ricinella *S. & B.*
C. apii *Fres.*
C. beticola *Sacc.*
C. catalpae *Wint.*
Sphaerostilbe coccophila *Tul.*
Meliola palmicola *Wint.*
Asterina inquinans *E. & E.*
Taphrina caerulescens *(D. & M.)*
Phyllactinia suffulta *(Reb.) Sacc.*
Uncinula clintonii *Pk.*
Microsphaera quercina *(Schw.) Burr.*
M. calocladophora *Atk.*
Sphaeria andropogicola *Schw.*
Rhytisma vaccinii *Earle*
Linospora ferruginea *E. & M.*
Phyllachora cyperi *Rehm.*
Phleospora mori *Sacc.*

Mrs Carolyn W. Harris, Brooklyn

Usnea barbata (*L.*) *Fr.*
U. barb. florida *Fr.*
U. barb. rubiginosa *Mx.*
U. longissima *Ach.*
Alectoria jub. chalybeiformis *Ach.*
Ramalina calic. fastigiata *Fr.*
R. calic. farinacea *Schaer.*
Evernia prunastri (*L.*) *Ach.*
Cetraria ciliaris *Ach.*
C. lacunosa *Ach.*
C. aurescens *Tuckm.*
Sticta pulmonaria (*L.*) *Ach.*
S. amplissima (*Scop.*) *Mass.*
Peltigera aphthosa (*L.*) *Hoffm.*
P. canina (*L.*) *Hoffm.*
P. polydactyla (*Neck.*) *Hoffm.*
P. rufescens (*Neck.*) *Hoffm.*
P. pulverulenta (*Tayl.*) *Nyl.*
Umbilicaria dillenii *Tuckm.*
U. vellea (*L.*) *Nyl.*
U. muhlenbergii (*Ach.*) *Tuckm.*
U. pustulata (*L.*) *Hoffm.*
Pyxine sorediata *Fr.*
Solorina saccata (*L.*) *Nyl.*
Parmelia perlata (*L.*) *Ach.*
Parmelia saxatilis (*L.*) *Fr.*
P. sax. sulcata *Nyl.*
P. sax. panniformis (*Ach.*)
P. caperata (*L.*) *Ach.*
P. conspersa (*Ehrh.*) *Ach.*
P. borreri *Turn.*
P. physodes (*L.*) *Ach.*
P. tiliacea (*Hoffm.*) *Fl.*
Physcia stellaris (*L.*) *Tuckm.*
P. aquila (*Ach.*) *Nyl.*
Theloschistes polycarpus (*Ehrh.*) *Tuckm.*
Pannaria lanuginosa (*Ach.*)
P. leucosticta *Tuckm.*
Leptogium pulchellum (*Ach.*) *Nyl.*
L. lacerum (*Sw.*) *Fr.*
L. tremelloides (*L.*) *Fr.*
Collema flaccidum *Ach.*
Stereocaulon paschale (*L.*) *Fr.*
Cladonia squamosa *Hoffm.*
C. furc. racemosa *Fl.*
Endocarpon fluviatile *DC.*
E. min. complicatum *Schaer.*
E. min. aquaticum *Schaer.*

Mrs E. Watrous, New York

Cortinarius violaceo-cinereus (*Pers.*) *Fr.*

Mrs E. C. Anthony, Gouverneur

Uredo polypodii (*Pers.*) *DC.*

M. S. Baxter, Rochester

Graphiola phoenicis (*Moug.*) *Poit.*

George E. Morris, Waltham Mass.

Tricholoma peckii *Howe*
Mycena strobilinoidea *Pk.*
Hygrophorus pudorinus *Fr.*
Cortinarius sanguineus (*Wulf.*) *Fr.*
Boletus parasiticus *Bull.*
Mutinus ravenelii (*B. & C.*) *Fisch.*
Calvatia elata (*Mass.*) *Morg.*
Hypoxylon howeanum *Pk.*
Cordyceps capitata (*Holmsk.*) *Lk.*
Cordyceps ophioglossoides (*Ehrh.*) *Lk.*
Helvella crispa (*Scop.*) *Fr.*
H. ephippium *Lev.*
H. macropus brevis *Pk.*
Geoglossum farlowi *Cke.*
G. peckianum *Cke.*
Bulgaria rufa *Schw.*

SPECIES NOT BEFORE REPORTED

C

Thalictrum occidentale Gray

Shore of Lake Champlain near Port Henry. The leaves of this plant bear some resemblance to those of Thalictrum dioicum, but in stature and time of flowering it suggests T. purpurascens to which it was doubtfully referred in a former report.

Conringia orientalis (L.) Dumort.

Along the N. Y. C. railroad near Utica. J. V. Haberer. This is an introduced plant having a tendency in some places to become a troublesome weed.

Sophia sophia (L.) Britton

Thin soil in rocky places. About the ruins of the old fort on Crown Point. May. This is Sisymbrium sophia L.

Geum vernum T. & G.

Mohawk flats. Deerfield, Oneida co. Abundant in a meadow near a little lake on the north side of Mohawk river about a mile below Utica. It may have been introduced from the west. It is distinguished from closely related species by its stalked receptacle. June. J. V. Haberer.

Crataegus champlainensis Sarg.

Crown Point and near North Albany. May and June. The species of Crataegus have recently been made the subject of special investigation by some of the botanists in this country. The result has been the recognition of many species previously overlooked or confused with other known forms. Good specific characters have been found in parts of the plant formerly disregarded or considered unreliable in the identification of species.

Crataegus pringlei Sarg.

Crown Point and near North Albany. May and June. This species may be recognized by the peculiar habit of its foliage.

The mature leaves, by the deflection of their margins, have a drooping appearance, the upper surface being convex, the lower concave. This is shown to some extent in the dried specimens in the herbarium. The leaves do not flatten fully in the plant press but present folds or wrinkles when dried.

Crataegus modesta Sarg.

Dry hills and slaty knolls. Near North Albany and Lansingburg. June. The specimens which we have referred to this species meet the description fairly well but the plant is quite variable. On dry clayey hillocks north of Albany it has a straggling starved appearance, bears small leaves and few or no thorns. On slaty knolls north of Lansingburg it is more thrifty, has larger leaves which are often somewhat three lobed by reason of the greater development of the basal lobes, and it bears more numerous thorns which are sometimes 2 inches long. It flowers a little later than the two preceding species and is also later in ripening its fruit. It is a rather small shrub, usually 4 to 6 feet high.

Crataegus holmesiana Ashe

Near North Albany and Lansingburg, also in Sandlake where it is the prevailing species. May. The number of stamens varies from 5 to 8, and serves when the plant is in blossom as a distinctive mark of the species. The fruit ripens early in September and has an agreeable flavor.

Crataegus pruinosa Wend.

Crown Point, North Albany and Lansingburg. The pruinosity of the fully grown fruit is a convenient mark for the recognition of this species.

Vernonia gigantea (Walt.) Britton

Stony, hilly pastures. New Hartford, Oneida co. September. J. V. Haberer.

Antennaria parlinii arnoglossa Fern.

Pastures. Crown Point. May.

Centaurea jacea L.

Douglaston, Queens co. August. Mrs M. A. Knickerbocker. It has also been reported from Deerfield by Dr Haberer but I have seen no specimens from that locality. The plant is sometimes cultivated for ornament and has escaped from cultivation.

Arctium minus Schk.

Near Loon lake station. July. This was formerly considered a variety of A. lappa.

Lactuca morssii Robins.

Clearings and waste places. North Elba and Loon lake station. July. In general appearance this species resembles L. canadensis and L. leucophaea. From the former it may be distinguished by its purplish or violet colored flowers and the shorter beaked achenia, from the latter by its snowy white pappus.

Hedeoma hispida Pursh

Thin naked soil covering rocks. Little Falls. June. Probably introduced from the west. J. V. Haberer.

Panicularia laxa Scribn.

Margin of a pond near Loon lake station. July. The specimens have the small few-flowered spikelets of this species but the upper sheaths do not overlap as in the typical form.

Mylia anomala (Hook.) S. F. Gray

Marshes. West Fort Ann. November. S. H. Burnham.

Scapania irrigua (Nees) Dumort.

Marshes. West Fort Ann. October. S. H. Burnham.

Stereocaulon denudatum Fl.

Bare rocks. Mt Marcy, Mt McIntyre and Mt Wallface. July. All the specimens are sterile.

Endocarpon fluviatile DC.

Near Chilson lake. June. Mrs C. W. Harris.

Cetraria aurescens Tuckm.

Bark of pine, Pinus strobus. Near Chilson lake. June. Mrs C. W. Harris.

Pannaria leucosticta Tuckm.

Granitic rocks. Near Chilson lake. July. Mrs Harris.

Lepiota adnatifolia n. sp.

Pileus thin except in the center, broadly convex or nearly plane, minutely granulose or squamulose, isabelline, alutaceous or reddish ferruginous, the margin usually appendiculate with fragments of the veil, flesh white; lamellae thin, moderately close, adnate, white; stem short, generally slightly thickened at the base, solid when young but sometimes becoming stuffed or hollow with age, glabrous or slightly squamulose below the small often evanescent ring, pallid or subrufescent; spores minute, .0002–.00024 of an inch long, .00016–.0002 broad.

Pileus 1–2.5 inches broad; stem 1–1.5 inches long, 2–4 lines thick. Ground under pine trees. Bolton and Hague, Warren co. September.

The color ornamentation and size are nearly the same as in L. granulosa, from which it differs in its slight veil, larger spores and specially in its adnate lamellae. By this character some species of Lepiota show an affinity with the genus Armillaria. Our four species having this character may be indicated by the subjoined synoptic table.

Plant growing on the ground . 1
Plant growing on decaying wood L. granosa
1 Plant having a disagreeable odor L. rugosoreticulata
1 Plant inodorous 2
2 Stem 1–2 lines thick, pileus generally umbonate L. amianthina
2 Stem 2–4 lines thick, pileus not umbonate. L. adnatifolia

Tricholoma rimosum n. sp.

Pileus fleshy, convex becoming nearly plane, often split on the margin, glabrous, hygrophanous, watery brown and shining

when moist, paler when dry, flesh colored like the pileus when moist, whitish when dry, taste farinaceous; lamellae thin, narrow, very close, rounded behind, adnexed, uneven on the edge, whitish or subcinereous; stem nearly equal, silky-fibrillose, hollow, whitish; spores elliptic, .0003–.00035 of an inch long, .00016–.0002 broad.

Pileus 1–1.5 inches broad; stem 1–2 inches long, 1.5–2.5 lines thick. Woods. Bolton. September.

This species is related to T. humile from which it may be distinguished by its smaller size, hollow silky fibrillose stem, the rimose margin of the pileus and its farinaceous taste.

Clitocybe regularis n. sp.

PLATE K, FIG. 1–7

Pileus thin, flexible, broadly convex becoming nearly plane, often slightly depressed in the center, orbicular, regular, whitish when moist, white when dry, flesh white, taste mild; lamellae thin, narrow, crowded, decurrent, whitish; stem firm, equal, glabrous, solid, rarely with a very small cavity, whitish, spongy thickened at the base; spores minute, .0002 of an inch long, .0001–.00012 broad.

Pileus 1–2.5 inches broad; stem about 1 inch long, 1.5–2.5 lines thick. Among fallen leaves in woods. Bolton. August.

This species is related to C. tornata, from which it differs in its thin flexible moist pileus, its distinctly decurrent lamellae and in its solid stem with the spongy mass of mycelioid tomentum at the base.

Clitocybe subconcava n. sp.

PLATE K, FIG. 8–13

Pileus thin, convex, deeply umbilicate, glabrous, hygrophanous, brownish or reddish brown and usually striatulate on the decurved margin when moist, whitish when dry; lamellae arcuate, decurrent, close, pallid or subcinereous; stem equal, firm, solid or stuffed, sometimes with a small cavity, slightly fibrillose, colored like the pileus; spores minute, .0002–.00024 of an inch long, .00012–.00016 broad.

Pileus 1–2 inches broad; stem 1–2 inches long, 1.5–2 lines thick. Pine woods. Bolton. August.

Closely related to C. c o n c a v a from which it may be separated by its much smaller spores and paler color. The decurved margin of the pileus is even, not wavy as in that species. It is also allied to C. c y a t h i f o r m i s and C. e x p a l l e n s, from both of which its smaller spores and deeply umbilicate pileus separate it. It is without any distinctive odor.

Pleurotus minutus n. sp.

Pileus minute, reniform or suborbicular, at first resupinate, sometimes becoming reflexed with age, often slightly depressed in the center; flocculose pruinose, white, the margin involute; lamellae unequal, very narrow, distant, decurrent, white or whitish; stem short, eccentric, curved, pruinose, whitish with a white mycelioid tomentum at the base.

Pileus 1–2 lines broad; stem about 1 line long. Much decayed wood of birch. Near Loon lake. July.

The very small size, narrow distant decurrent lamellae and pruinose pileus and stem are the prominent characters of this minute species. The specimens are sterile.

Lactarius foetidus n. sp.

Pileus fleshy, firm, nearly plane or centrally depressed, minutely downy or velvety, pale yellow or buff, becoming brownish where bruised, flesh whitish, milk white, taste mild, odor fetid; lamellae subdistant, adnate or slightly decurrent, yellowish white, becoming reddish brown where wounded or bruised; stem short, equal, solid, glabrous, whitish; spores broadly elliptic or subglobose, .00024–.00032 of an inch long, nearly as broad.

Pileus 2–3 inches broad; stem 1–2 inches long, 4–6 lines thick. Low damp ground in woods. Snyders, Rensselaer co. August.

The fetid disagreeable odor and buff color of the pileus are distinguishing characters of this rare species. The downy surface of the dry pileus is soft to the touch, like that of L. v e l l e r e u s.

Hygrophorus glutinosus n. sp.

Pileus fleshy, firm, convex, glutinous, white, sometimes tinged with yellow by the drying of the gluten, the margin involute, flesh white; lamellae subdistant, adnate, white; stem equal, solid, white, floccose tomentose and glutinous below the glutinous annulus, studded above with glandular drops of moisture which in drying form reddish dots; spores .0003–.0004 of an inch long, .0002–.00024 broad.

Pileus 1–2 inches broad; stem about 1 inch long, 3–4 lines thick.

In the fresh plant the lower part of the stem appears to be coated with a floccose tomentum smeared with gluten, in the dried plant the gluten assumes an orange yellow or bright straw color and the tomentum disappears. The species differs from H. gliocyclus in its adnate lamellae and from H. eburneus in its solid stem with reddish points at the top.

Volvaria speciosa Fr.

Westfield, Chautauqua co. June. E. B. Sterling.

Volvaria hypopithys Fr.

Lake Placid. September. Miss N. L. Marshall.

Cortinarius submarginalis n. sp.

PLATE L, FIG. 6–10

Pileus fleshy, firm, convex becoming nearly plane, or concave by the elevation of the margin, viscid when moist, yellowish brown, generally a little paler on the rather definite and commonly fibrillose margin, flesh whitish; lamellae thin, close, adnate, creamy yellow when young, soon cinnamon; stem rather long, equal or slightly thickened at the base, solid, silky fibrillose, slightly viscid, whitish or pallid; spores subelliptic, .0004–.0005 of an inch long, .0002–.00024 broad.

Pileus 2–4 inches broad; stem 3–6 inches long, 4–6 lines thick.

Low moist places in woods. Bolton. August.

The margin of the pileus is generally paler than the rest and separated from it by a definite line. It is from 3–6 lines broad

and is sometimes curved upward and conspicuously fibrillose. This difference between the margin and the rest of the pileus is not clearly shown in the dried specimens. The species belongs in the section Myxacium.

Cortinarius obliquus n. sp.

PLATE L, FIG. 1–5

Pileus rather thin, broadly convex or nearly plane, dry, silky fibrillose, white or grayish, generally with a slight violaceous tint, flesh whitish; lamellae thin, close, adnate or slightly rounded behind, minutely crenulate on the edge and obscurely transversely striate on the sides, deep violet becoming cinnamon brown with age; stem equal, solid, shining, silky fibrillose, whitish tinged with violet, violet within, with an abrupt flattened oblique bulb at the base; spores elliptic, uninucleate, .0003 of an inch long, .0002 broad.

Pileus 2–3 inches broad; stem 2–3 inches long, 3–5 lines thick. Among fallen leaves in woods. Bolton. August.

This species is well marked by the white or grayish white pileus, the deep violet or almost amethystine color of the young lamellae and the oblique flattened bulb of the stem. It belongs to the section Inoloma. C. albidus Pk. has an oblique bulb at the base of the stem and a white pileus but it belongs to the section Phlegmacium as its pileus is viscid. Its young lamellae are also white.

Cortinarius violaceo-cinereus (Pers.) Fr.

Pine woods. Hague, Warren co. June. Mrs E. Watrous. A large cespitose form. A scattered or gregarious form occurs in woods near Bolton. September. In *Systema mycologicum* and in *Epicrisis*, Fries gives C. violaceo-cinereus as the name of the species, but in *Hymenomycetes Europaei* he changed the form of the name to C. cinereo-violaceus without giving any reason for the change. This name has been adopted in *Sylloge*, but we have retained the older form.

Boletus multipunctus n. sp.

PLATE K, FIG. 19–22

Pileus fleshy, convex or nearly plane, dry, brownish ocher, sometimes with a slight reddish tint, the central part adorned with many minute slightly darker areolate spots or dots, flesh whitish, taste mild; tubes small, adnate or depressed about the stem, ventricose in the mass, the mouths subrotund, at first whitish, becoming greenish yellow; stem equal or tapering upward, pallid, solid, fibrous striate; spores dark olive green, oblong, .00045–.0006 of an inch long, .00016–.0002 broad.

Pileus 3–5 inches broad; stem 3–5 inches long, 4–8 lines thick. In woods. Bolton. August.

The species belongs to the section Edules. It was not found in sufficient quantity for testing its edibility but it is probably edible.

Fistulina pallida B. & R.

Pittsford, Monroe co. July. F. S. Boughton. These specimens correspond to the description of F. pallida except in their larger size. They are distinct from F. firma Pk. in their darker color and decurrent tubes.

Poria myceliosa n. sp.

Subiculum membranaceous, separable from the matrix, connected with white branching strands of mycelium which permeate the soft decayed wood, or with radiating ribs which run through the broad sterile fimbriate white margin; pores very short, subrotund angular or subflexuous, the dissepiments thin, acute, dentate or slightly lacerate, pale yellow; spores minute, subglobose, .00008–.00012 of an inch broad. Round Lake, Saratoga co. August.

This fungus forms patches several inches in extent on much decayed wood of hemlock. It follows the inequalities of the surface on which it grows. It is scarcely more than half a line thick. The pores develop from the center toward the margin and at first are mere concavities in the subiculum. The species is apparently related to P. tenuis Schw., from which it

differs in habitat, color and the prominent mycelial strands. In this last character it bears some resemblance to P. vaillantii (DC.) Fr.

Hydnum umbilicatum n. sp.

PLATE K, FIG. 14–18

Pileus fleshy, convex, glabrous, umbilicate, reddish buff or burnt sienna color, flesh white, taste mild; aculei plane in the mass, fragile, nearly equal, a little paler than the pileus; stem nearly equal, glabrous, solid, whitish; spores globose, .0003–.0004 of an inch in diameter.

Pileus 6–18 lines broad; stem 1–1.5 inches long, 2–4 lines thick. Among fallen leaves in woods. Hague. September.

This species is related to H. repandum and H. rufescens, from both of which it is easily separated by its small but usually deep and distinct umbilicus. Sometimes a definite line separates the paler margin from the more highly colored center of the pileus. In the last report it was mentioned as a form of H. rufescens.

Thelephora multipartita Schw.

Grassy ground under trees. Bolton. August. This species is variable in size, in the number of divisions of the pileus and consequently in its general appearance. It is related to T. anthocephala and T. caryophyllea, but the upper surface of the pileus or of its component parts is usually paler than in these species.

Thelephora exigua n. sp.

Pileus very thin, submembranaceous, tubaeform or infundibuliform, faintly radiately fibrous striate, slightly lacerate on the margin, pale alutaceous; hymenium even or faintly striate, pruinosely pubescent, pallid; stem slender, solid, pruinosely pubescent, brownish; spores elliptic, .00016 of an inch long, about half as broad.

Pileus 1.5–3 lines broad; stem 2–3 lines long. Vegetable mold. Westport, Essex co. October.

This minute species may be separated from T. ravenelii Berk. and T. regularis Schw. by its smaller size and by the minute pubescence of its hymenium and stem.

Corticium portentosum B. & C.

Decorticated wood of spruce. North Elba. July.

Corticium arachnoideum Berk.

Decorticated wood of pine. Bolton. September.

Peniophora affinis Burt *in litt.*

Bark of dogwood, Cornus florida. East Schodack. August. Closely allied to P. laevis (Fr.) Burt.

Peniophora parasitica Burt *in litt.*

Under side of branches of juniper, Juniperus communis, lying on the ground. Hague. September.

Asterostroma bicolor E. & E.

Decaying wood of spruce. Floodwood, Franklin co. August. E. A. Burt.

Sebacina calcea (Pers.) Bres.

Under side of dead spruce branches. Hague. September.

Clavaria bicolor n. sp.

Small, 8–12 lines high, gregarious; stem slender, .5–1 line thick, straight or flexuous, solid, tomentose, pale yellow, divided above into two or more short, orange colored compressed branches which are themselves once or twice dichotomously divided, tips acute, concolorous.

Under pine trees. Bolton. September.

The rather tough tomentose stem indicates an affinity to the genus Lachnocladium.

Phallogaster saccatus Morg.

Decaying wood. Westfield, Chautauqua co. June. E. B. Sterling.

Cyathus lesueurii Tul.

Lyndonville, Orleans co. C. E. Fairman. Also in Bethlehem, Albany co. In our specimens there are small cavities in the

interior of the peridium near its base in each of which a sporangiole rests. The funiculus is short, but when moist it can be stretched to a great length. This species may be distinguished from C. vernicosus by the less spreading margin of the open peridium and by its much larger spores.

Craterium minimum B. & C.

Dead sticks and leaves. West Albany. C. cylindricum Massee is a synonym.

Craterium minutum (Leers) Fr.

On mosses. East Berne, Albany co. August.

Didymium fairmani Sacc.

On foliage of two leaved Solomon's seal, Unifolium canadense. Ridgeway, Orleans co. C. E. Fairman. Closely allied to D. melanospermum, from which it differs in its rather smaller peridium and spores. The typical form is sessile, but specimens sometimes occur with a short slender stem.

Physarella multiplicata Macb. *in litt.*

Spreading over ground and living plants. Menands, Albany co. June. The white plasmodium spreads over anything in its way and the mature fungus develops from it in 24 hours in very warm weather.

Empusa grylli Fresen.

It attacks and kills grasshoppers. Surfaces on which the dead bodies of the grasshoppers rest become whitened by the pyriform conidia of the fungus shed from the bodies of the insects.

Marsonia pyriformis (Riess) Sacc.

Upper surface of leaves of silver poplar, Populus alba. Penn Yan. September. F. C. Stewart.

Septoria polygonina Thum.

Living leaves of the fringed black bindweed, Polygonum cilinode. Near Loon lake. July. In our specimens the

spots on the leaves have not the violaceous margin attributed to the typical form of the species and they are generally marked by a few elevated lines or ridges. Their color is usually reddish brown rather than ochroleucous. The difference in the host plants is probably the cause of the difference in the spots.

Chalara paradoxa (Seynes) Sacc.

Decaying pineapple. Menands. June. The inner flesh of the affected fruit is blackened by the fungus.

Colletotrichum antirrhini Stewart

Living stems and leaves of great snapdragon, Antirrhinum majus. Geneva. September. F. C. Stewart.

Colletotrichum rudbeckiae n. sp.

Pustules minute, numerous, closely gregarious, round or hysteriiform, black, at first covered by the epidermis, then erumpent; setae few, black; spores straight or slightly curved, acute, hyaline, .0005–.0006 of an inch long, .00016 broad. Dead stems of cultivated cone flower, Rudbeckia laciniata. Geneva. July. F. C. Stewart.

Helvella adhaerens n. sp.

PLATE L, FIG. 11–15

Pileus thin, irregular, deflexed, whitish or smoky white, becoming brownish with age or in drying, the lower margin attached to the stem, even and whitish beneath; stem slender, even, solid, pruinosely downy, smoky white or brownish, the upper part concealed by the deflexed pileus and smaller than the lower exposed part; asci cylindric, 8 spored; spores elliptic, often uninucleate, .0007–.0008 of an inch long, .0005 broad; paraphyses filiform, hyaline, thickened or subclavate at the top.

Ground in woods. Bolton and Hague. August and September. Related to H. elastica, from which it is easily distinguished by having the deflexed margin of the pileus attached to the stem. When young and fresh the whole plant is whitish or dingy white, but it is apt to become brownish with age or in drying.

Lachnella corticalis (Pers.) Fr.

Dry naked bark or among mosses on the base of living aspens, Populus tremuloides. North Elba. July.

Orbilia luteo-rubella (Nyl.) Karst.

Damp decaying wood, specially of deciduous trees. North Elba. July. A common species, usually becoming more highly colored in drying.

Anthostoma dryophilum (Curr.) Sacc.

Dead branches of chestnut. Lyndonville, Orleans co. C. E. Fairman.

Mycenastrum spinulosum Pk.

Grassy ground about the ruins of the old fort on Crown Point. September. Three young specimens and two fragments of an old specimen were found. This material is scarcely sufficient for a satisfactory identification of the species, but the peculiar threads of the capillitium and the character of the spores indicate this species. The locality, however, is very distant from that of the original specimens. It is desirable that mature specimens in good condition may yet be found.

D

REMARKS AND OBSERVATIONS

Hepatica acuta (Pursh) Britton

Vaughns, Washington co. April. S. H. Burnham. The specimens represent a variety in which each of the three lobes of the leaf is itself three lobed.

Castalia tuberosa (Paine) Greene

Abundant in the sloughs and still waters about Fort Ann, Washington co. In deep water the leaves float on the surface, but in shallow water they stand erect above the surface, supported by their stout firm petioles.

Draba incana arabisans (Mx.) Wats.

Precipices of Mt Wallface. This is the only locality in the state, so far as known to me, where this plant is found. It flowers in June or early in July. Specimens collected July 19 were past flowering.

Meibomia paniculata (L.) Kuntze

In rocky places at Bolton a form occurs in which the midrib and, to some extent, the principal veins are bordered by a pale stripe.

Viburnum pauciflorum Pylaie

In our state this species is apparently limited to the Adirondack region and is scarce even there. It occurs sparingly along some of the cool shaded streams that flow down the steep rocky sides of Mt Marcy, Mt McIntyre and Mt Clinton. It is in flower in the latter part of June, but the fruit is not ripe before August.

Ludwigia alternifolia L.

Abundant in a swampy place about a mile west of Menands. The persistent colored foliaceous lobes of the calyx give it the appearance of being in flower late in the season, even when its fruit is mature.

Chamaenerion angustifolium (L.) Scop.

A pale flowered form occurs near Loon lake. It is intermediate between the common form and the white flowered form.

Galinsoga parviflora hispida DC.

Waste places. Bolton. August. Escaped from cultivation. More hairy or hispid than the common form and having the pappus narrowed above into a bristle. The upper part of the branches and specially the peduncles are glandular hairy in our specimens. These characters and the coarsely toothed margin of the thicker leaves give the plant a peculiar appearance and would seem to make it worthy of specific distinction.

Rudbeckia triloba L.

East Schodack, Rensselaer co. August. Neither the *Manual* nor the *Illustrated flora* credits this species to New York, but it has been found growing wild in Dutchess and Ulster counties. The station in Rensselaer co. is the most northern one in which I have found it.

Gaylussacia resinosa glaucocarpa Robinson

Fort Ann, Washington co. and Glen lake, Warren co. August. S. H. Burnham.

Euphorbia platyphylla L.

Rare. On the east shore of Bulwagga bay southeast of Port Henry. September.

Betula papyracea minor Tuckm.

Plentiful and fertile on the open summit of Mt Clinton.

Juniperus communis alpina Gaud.

The alpine juniper is more abundant on Mt Clinton than on the higher summit of its near neighbor, Mt McIntyre. It bears fruit sparingly here. The arbor vitae, Thuja occidentalis, ascends to the open summit of this mountain, but the trees are small and unthrifty.

Potamogeton lonchites Tuckm.

Small but fertile plants of this pond weed and of P. obtusifolius, occur in shallow water in a small pond near Loon lake station.

Juncoides spicatum (L.) Kuntze

The spiked wood rush was found growing on the top of Mt Wallface in 1898. This remained the only known station for it in our state till this year. In July fine fruiting specimens of it were found growing near the base of the cliffs on the western side of Indian pass near its southern end. In these specimens the lowest fruit cluster is 1 or 2 lines distant from the rest.

Eleocharis diandra Wright

This beautiful spike rush has generally been treated as a mere form of the ovoid spike rush, E. ovata, but a fine series of specimens collected on the shore of Oneida lake by Dr Haberer and contributed by him to the herbarium leads me to keep it distinct.

Scirpus peckii Britton

A station for this rare bulrush was discovered in July near Loon lake in Franklin co.

Scirpus rubrotinctus confertus Fern.

Swampy places near Loon lake. July. This variety was found growing with the typical form, which is not rare in the Adirondack region.

Scirpus atrocinctus brachypodus Fern.

Swampy or wet places. North Elba and near Loon lake. This bulrush also grows in company with the typical form and clearly passes into it by intergrading forms. July.

Homalocenchrus oryzoides (L.) Poll.

Low ground on the shore of Lake George at Hague. A form in which all the panicles are included in the leaf sheaths, except in occasional specimens in which the terminal panicle is exserted. September.

Agrostis alba L.

Specimens of this common and useful grass were collected near Loon lake. In them the glumes of nearly all the flowers of the panicle are elongated to three or four times their usual size. This gives the grass a singular appearance. These flowers are sterile. A similar form of A. alba vulgaris is already represented in the herbarium.

Poa flava L.

This grass usually grows in low wet ground or in marshy places, but a slender form with small two or three flowered spikelets scarcely more than 1 line long occurs in the Adirondack region growing on rocky ledges. Specimens were collected on the cliffs of Mt Wallface in July.

Equisetum littorale gracile Milde

Gravelly inundated shore of Oneida lake. June. J. V. Haberer.

Lycopodium annotinum L.

A slender form of this species is found in Indian pass, approaching variety pungens in character but having the leaves more distant and spreading. It is intermediate between the variety and the common form.

Lycopodium clavatum monostachyon Hook.

Rocky places. North Elba. July. Growing with the common form.

Woodsia obtusa angusta Pk.

Rocky places in the Highlands. Specimens of this variety were collected many years ago on Crow's Nest mountain between

Cornwall and West Point. In his *List of North American Pteridophytes*, Mr B. D. Gilbert, to whom specimens were sent, has recognized this variety and published a description of it under the name here given. This variety is represented on the sheet placed in the herbarium by Dr Torrey to illustrate the species, but no locality is recorded for it. The broader or common form is represented by specimens from Rensselaer and Warren counties.

Amanita phalloides striatula n. var.

Pileus thin, nearly plane, slightly striate on the margin, white; stem long, slender, slightly sheathed at the base by the remains of the ruptured volva. Bolton. August.

This amanita departs so distinctly from the character of A. phalloides in having the margin somewhat striate, that it would seem at first thought best to separate it as a distinct species, but that is such a variable species and this is so closely allied, differing only in the striate margin from small forms of A. phalloides verna, it seems best to regard it as a mere variety. The pileus is 1–2 inches broad and the stem 3–5 inches long and 2–3 lines thick, with a small bulb at the base. The annulus is well developed and the spores are globose and of the same size as in the typical form of the species.

Amanita muscaria formosa (G. & R.) **Fr.**

If we regard the beautiful amanita as a mere variety of the fly amanita it may be said to be the prevailing representative of the species in the eastern and northern parts of the state. It was very abundant the past season about Lake George. Its pileus is generally pale yellow or citrine color and its warts are also pale and easily removable. Sometimes specimens occur which are red or orange in the center of the pileus. It is apparently less poisonous than the true fly amanita, or else some persons are not easily affected by it. An instance was recently reported to me in which one person by mistake cooked and ate two caps of it without experiencing any ill results. This is the third person who has made a similar report to me.

Still the relationship is so close between this variety and the true fly amanita that I would not advise any one to experiment with it as food.

Tricholoma peckii Howe

This species agrees very closely with the description given by Fries of Armillaria aurantia, from which it scarcely differs except in the character of the ornamentation of the stem and in the absence of any semblance or form of an annulus. In our plant the scales of the stem are very small and not verrucose nor concentrically arranged as indicated by the Friesian description and figure of A. aurantia in *Icones Hymenomycetum.* Fries himself says that there is no distinct annulus present in A. aurantia, but the scales of the stem definitely and concentrically ceasing 2–3 lines from the top of the stem afford an annular zone. It seems strange that on such slight evidence as this he should place the species in the genus Armillaria while its alliance with the genus Tricholoma is much more strongly indicated by other characters. In our plant there is a slight downy pruinosity on the margin of the pileus in the young state, which is good evidence of its relationship to the genus Tricholoma, but it is possible that this character is not present in the European plant, for I find no mention made of it in the descriptions of A. aurantia. The viscid pileus and the change of color assumed by the lamellae with advancing age in our plant point so clearly to an intimate alliance with such species as T. flavobrunneum, T. albobrunneum, T. ustalis, and T. stans, that stronger evidence than any we have yet seen in it would be necessary to induce us to disregard this alliance and place it in Armillaria. It is perhaps worthy of note that while designating the European plant, which he considers the same as the Agaricus aurantius of Schaeffer, as an Armillaria, Fries, in the work already mentioned, has actually placed both the description and the figure of it among the descriptions and figures of species of the genus Tricholoma, and he himself says that the species is ambiguous between Armillaria and

Tricholoma. We do not think there is any ambiguity about the proper place for the American plant. Schaeffer describes his plant as having the pileus striate with filaments, and the stem also as striate with filaments, destitute of a veil but having a spurious annulus. His figure supports this description and also indicates the presence of concentrically arranged squamules on the stem. Gillet says that the plant has an incomplete annulus and his figure of the species, like that of Schaeffer, indicates one formed by the abrupt termination of the scaly surface of the stem. He also attributes a strong nauseous odor and an acrid and bitter taste to the plant, but says nothing of the farinaceous odor and taste which is so evident in our plant. These discrepancies between the European plant and the American lead us to keep our plant separate, though it may be only a variety.

Tricholoma fallax Pk.

In *Illustrations of British fungi* 8:1151 this species is figured with white lamellae. I have never seen the American plant with white lamellae, not even when young. They are yellow when young inclining to ochraceous as they become older. In the moist plant they are a little paler than the pileus, but when dry they have nearly the same color.

Collybia confluens campanulata n. var.

Pileus campanulate, 1–3 inches broad; lamellae and stem whitish or subcinereous. Growing in circles under pine trees. Bolton. September.

This variety is remarkable for the large size and persistently campanulate form of its pileus and for its habit of growing in clusters which stand in arcs of circles. The clusters are often so compact that the pilei are crowded and very irregular in consequence.

Another variety was found in small quantity near Bolton in August. In it the stem and lamellae are clear white. I would call it variety n i v e i p e s.

Omphalia campanella sparsa n. var.

Pileus convex, with a small umbilicus; lamellae yellow, decurrent, rather broad, subdistant, interspaces veiny; stem long, slender, equal, straight, glabrous, with a copious tawny tomentum at the base and sometimes a slight tawny mealiness at the top, hollow, black or brownish black.

Scattered or loosely gregarious. Among fallen leaves and sticks under pine trees. Bolton. August. Several varieties of this species have already been described but this corresponds to none of them. In its habitat and mode of growth it approaches varieties badipes and papillata, from the former of which it differs in the color and character of both pileus and stem, and from the latter in the shape of the pileus. The small umbilicus is not deep and it sometimes contains a small blackish papilla. The pileus is 4–6 lines broad and the stem 1–2 inches long but scarcely more than half a line thick.

Nyctalis asterophora Fr.

This fungus with us is nearly always affected by what seems to be a parasitic fungus which covers the pileus with a pulverulent coat of tawny brown or cervine stellate spores. This appears to prevent in some cases the development of the lamellae and consequently of its own spores. But the form having lamellae does sometimes occur. Such specimens were found near Bolton in August. When young the pileus is white and its margin involute. It has a farinaceous taste and odor. The stem also is at first white externally, but brown within. It is stuffed or hollow. The lamellae are rather distant and narrow. Such specimens sometimes become pulverulent and discolored after collection and before they can be dried.

Lentinus ursinus Fr.

This species varies beyond the limits assigned to it in the description. Specimens were found growing on an old prostrate birch trunk, Betula lutea, near Bolton, that were from 2–4 inches broad. When young the pileus is convex with an involute margin, glabrous and whitish, but with advancing

age a fuscous tomentum appears about the base and sometimes extends till it covers the whole surface. The flesh is rather thick, tough and flexible, and has a hot peppery taste. The edges of the lamellae are dentate rather than lacerate. Sometimes the pilei are clustered or imbricated.

Lenzites betulina radiata n. var.

Pileus thin, about 1 line thick, 1.5-3 inches broad, coriaceous, velvety hairy, narrowly multizonate, beautifully radiate striate, brown, substance white; lamellae unequal, occasionally forked, not anastomosing, smoky white or brownish. Dead trunks of beech. Hague. September.

The radiate striate appearance of the surface of the pileus is due to a linear arrangement of minute tufts of hairs radiating from the base to the margin. In the description of the species the lamellae are said to anastomose, but in this variety they do not, and in most American specimens that I have seen and that have been referred to this species, the lamellae are simple or occasionally branched. The species must be very variable if reliance is to be placed on the illustrations of it by European authors. Schaeffer's table 57 represents a thin nearly plane pale form with lamellae irregularly branched and slightly anastomosing, Berkeley's *Outlines* t. 15 f. 3 shows a thick triquetrous form with lamellae abundantly anastomosing, and Cooke's *Illustrations of British fungi* t. 1145 A indicates a thin brown zonate hairy pileus with white lamellae sparingly forked but not anastomosing. This corresponds well to our common American form except in the white color of the lamellae.

Hypholoma aggregatum sericeum n. var.

About old stumps in woods. North Bolton. September. This variety differs from the typical form of the species in its larger size and in having the pileus silky fibrillose and destitute of spots or scales. For a more full description see the part of this report devoted to edible fungi.

Boletus chrysenteron deformatus n. var.

Pileus small, scarcely more than an inch or an inch and a half broad, very irregular, brick red or tawny red; stem very short, often irregular, ventricose or tapering downward.

Bare earth on sloping banks by roadside. Bolton. August. The stem is but little longer than broad, and the pileus scarcely rises above the surface of the earth.

Cyclomyces greenii Berk.

In 1872 a single specimen of this rare fungus was found in Sterling, Cayuga co. A second specimen of it was found in September of thė present year near Bolton, Warren co. This specimen is peculiar in having two stems but one pileus.

Mucronella minutissima conferta n. var.

Aculei very numerous, crowded and forming continuous patches. Otherwise as in the typical form. Decaying wood of birch, Betula lutea. Near Loon lake. July.

E

EDIBLE FUNGI

Tricholoma russula (Schaeff.) Fr.

REDDISH TRICHOLOMA

PLATE 77, FIG. 1–5

Pileus fleshy, firm, convex becoming nearly plane or sometimes concave above by the elevation of the margin, viscid when moist, often minutely squamulose spotted in the center, slightly floccose pruinose on the margin when young, pale pink or rosy red, flesh white, taste mild; lamellae thin, moderately close, slightly rounded behind, white usually becoming reddish spotted with age or where wounded; stem firm, solid, white, often with reddish stains toward the base; spores white, .00025–.0003 of an inch long, .00016 broad.

The reddish tricholoma is a pretty mushroom. Its cap with us is usually a pale pink or rosy red, though the European plant is sometimes figured with a much brighter color and the typical form is described by Schaeffer as pale purple. He also describes and figures his plant as having the cap finely punctate or dotted,

but I have seen no American specimens showing this character fully. The dots in our plant are generally limited to the central part of the surface of the cap, and sometimes they are wanting entirely in the young plant. The reddish color is similar to that seen in some species of Russula and is suggestive of the specific name of this mushroom. It may be distinguished from similarly colored species of the genus Russula by the downy pruinosity of the margin of the cap in the young plant, by the different texture of its flesh and the different shape of its spores. The color of the cap of the European plant is said to be varied sometimes with yellow spots but I have seen no such variation in the American plant. The cap being viscid when moist is often soiled by adhering particles of dirt, fragments of twigs or fallen leaves.

The gills are white but sometimes become spotted with reddish hues when old or bruised. They are slightly excavated or notched on the edge at the end next the stem. The stem is short in proportion to the size of the mushroom, solid, and commonly white, specially in the young plant, but when old it is often more or less varied with reddish stains. It is sometimes slightly adorned with flocculent particles or scales near the top. The cap is 2–5 inches broad; the stem 1–2 inches long and 5–8 lines thick. The plants are found late in the season growing in thin woods either singly or in tufts. When growing in tufts the caps are often irregular from mutual pressure. From my own experience in eating this mushroom I am prepared to indorse Mr McIlvaine's words concerning it. "It is an excellent fungus, meaty, easily cooked and of fine flavor."

Hygrophorus laurae Morg.

LAURA'S HYGROPHORUS

PLATE 77, FIG. 6–14

Pileus fleshy, firm, convex becoming nearly plane or centrally depressed, sometimes umbonate, glutinous, white, usually clouded with brown, tawny brown or reddish brown in the center, flesh white; lamellae distant, decurrent, white; stem equal or tapering downward, solid, glutinous, roughened at the top

with scaly points, white or yellowish white; spores white, elliptic, .00025–.0003 of an inch long, .00016–.0002 broad.

This hygrophorus is a beautiful mushroom when fresh but its cap and gills change color in drying, by which it loses much of its beauty. Both cap and stem are smeared with a viscid substance or gluten that makes it unpleasant to handle. In the typical form the cap is white except in the center where it has a reddish or brownish tinge which sometimes spreads faintly toward the margin, but there is a variety in which the cap is entirely white or only faintly tinged with yellow. We have named this variety unicolor. Sometimes the center is slightly prominent or umbonate and the margin is irregular or wavy. The gills are decurrent and rather wide apart. They are white when fresh, but like the cap they become brown or reddish brown in drying. The stem is white or nearly so, solid, commonly tapering to a point at the base but sometimes nearly equal in all its parts. Its viscidity makes it difficult to pull the plant from its place of growth with the fingers.

The cap is 1–4 inches broad; the stem 1–4 inches long and 2–6 lines thick. This mushroom grows among fallen leaves in woods and appears during August and September. It appears to be peculiar to this country. It is related to the ivory hygrophorus and the goat moth hygrophorus of Europe but from the former it differs in its solid stem, elliptic spores and change of color in drying and from the latter by the absence of odor. I have eaten the white form only, but give a figure of the other also.

Clitopilus abortivus B. & C.

ABORTIVE CLITOPILUS

PLATE 78, FIG. 13–19

Pileus fleshy, firm, convex nearly plane or sometimes slightly depressed in the center, regular or occasionally irregular on the margin, dry, clothed at first with a minute silky tomentum, becoming smooth with age, gray or grayish brown, flesh white, taste and odor subfarinaceous; lamellae thin, close, adnate or strongly decurrent, whitish or pale gray when young, becoming salmon

colored with age; stem nearly equal, solid, minutely flocculose or fibrous striate, colored like or a little paler than the pileus; spores angular, uninucleate, salmon color, .00035–.0004 of an inch long, .00025–.0003 broad.

The abortive clitopilus takes this name because it is usually found growing with an imperfectly developed subglobose form in which there is no distinction of cap, stem or gills. It is simply an irregularly rounded mass of cellular tissue of a whitish color, originally described as a subglobose umbilicate downy mass. It is not always umbilicate nor is the surface always downy. It grows singly or in clusters of two or more.

The well developed form is generally a clean neat appearing mushroom but one of a very modest unattractive grayish colored cap and stem and with gills similarly colored when young, but becoming salmon hued when mature. The flesh is white and has a farinaceous taste and odor though the last is not always distinct unless the flesh is broken. The surface of the cap is usually coated when young by a minute silky flocculence but with advancing age this disappears or becomes scarcely visible. The gills are often very decidedly decurrent in old or fully expanded plants but only slightly so in young plants. When young they have a pale grayish color but with advancing age they assume the salmon color of the spores. They are closely placed to each other and not all of equal length. The stem is nearly equal in diameter in all its parts, solid, minutely flocculose or downy and sometimes slightly fibrous. Its color is similar to that of the cap though it is often paler.

The cap is 2–4 inches broad; stem 1.5–3 inches long and 3–6 lines thick. The species is commonly gregarious in its mode of growth, but sometimes it is single, sometimes tufted. It grows on the ground and on much decayed wood, either in woods or in open places and may be found from August to October.

When taken in good condition and properly cooked it is an excellent mushroom. If stewed gently for a short time it is less agreeable than if thoroughly cooked or fried in butter. The abortive form is also edible and is thought by some to be even better than the ordinary form.

Clitopilus micropus Pk.

SHORT STEMMED CLITOPILUS

PLATE 78, FIG. 1–12

Pileus thin, fragile, convex or centrally depressed, umbilicate, silky, gray, often with one or two narrow zones on the margin, taste and odor farinaceous; lamellae narrow, close, adnate or slightly decurrent, gray becoming salmon color with age; stem short, solid or with a slight cavity, often slightly thickened at the top, pruinose, gray, with a white mycelioid tomentum at the base; spores angular, uninucleate, salmon color, .0003–.0004 of an inch long, .00025–.0003 broad.

The short stemmed clitopilus is a small mushroom and not very plentiful and for these reasons it is not very important as an edible species, but it sometimes occurs in such abundance as to make it possible to obtain a sufficient number for the table. Its color is similar to that of the preceding species but in size it is much less. Its cap is thin and tender, broadly convex or centrally depressed. It is umbilicate and has a silky surface which is sometimes marked with one or two narrow zones near the margin. The gills are rather narrow and closely placed, broadly attached to the stem or slightly decurrent, and gray when young becoming salmon color when mature. The stem is short even when growing among fallen leaves or in grassy places, it is usually solid but in large or old specimens it is sometimes hollow. Its color is similar to that of the cap but it is slightly pruinose above and with a white tomentum at the base. In large and irregular specimens it is sometimes eccentric.

The cap is 6–16 lines broad; the stem is generally less than an inch long and is 1–2 lines thick. The mushrooms are found among fallen leaves in thin woods or in open grassy places and occur from July to September. They have a farinaceous or mealy flavor which is destroyed by cooking.

Pholiota squarrosa Mull.

SCALY PHOLIOTA

PLATE 79, FIG. 1–7

Pileus fleshy, firm, convex or nearly plane, dry, adorned with floccose tawny spreading or recurved scales, tawny, paler or yellowish on the margin, flesh whitish; lamellae thin, close, emarginate, adnexed, whitish becoming pale olivaceous, finally brownish ferruginous; stem rather long, firm, nearly equal, adorned with revolute scales, stuffed or hollow, tawny ferruginous, paler above when young, whitish above the commonly laciniate annulus; spores brownish ferruginous, elliptic, .00025–.0003 of an inch long, .00016–.0002 broad.

The scaly pholiota is not a very common mushroom but it is attractive in appearance. It is closely related to the sharp scale pholiota which it resembles in general appearance but from which it differs in its dry, not viscid, cap, in its scales which are flat instead of terete and not prominent and erect on the disk as in that species, and in its larger spores. The European plant is represented both by Schaeffer and by Bulliard as sometimes having a prominent and rather pointed elevation or umbo in the center of the cap, but I have not seen such a form here. In the American plant the young plant is almost hemispheric becoming convex or nearly plane with age. Its margin is paler than the center, fading to a yellowish color. The gills are thin and closely placed side by side. At the stem end they are more or less excavated on the edge. In the very young plant they are concealed by the veil and the incurved margin of the cap. They are then whitish but after exposure they became tinged with pale yellowish green and finally they assume a dull rusty brown hue. The stem is rather long, firm and scaly like the cap. It is stuffed or hollow, rusty tawny and furnished with an imperfect ragged collar near the top. This is at the upper termination of the scaly part and above it the stem is smooth and whitish. The cap is 2–4 inches broad; the stem is 3–5 inches long and 4–6 lines thick. The plants grow on old stumps and prostrate trunks of trees in woods, often

forming dense tufts. In such cases the caps are apt to be irregular and the stems narrower toward the base. They occur in August and September.

Hypholoma aggregatum sericeum Pk.

SILKY TUFTED HYPHOLOMA

PLATE 79, FIG. 8-14

Pileus fleshy, thin, oval when young, soon becoming campanulate or convex, silky fibrillose, white becoming grayish white with age, flesh white, taste mild; lamellae thin, close, adnate or slightly rounded behind, concealed by the veil in the young plant and then white, brown with a purplish tint when mature; stem long, flexuous, hollow, striate at the top, white; spores purplish brown, elliptic, .0003 of an inch long, .00016 broad.

The silky tufted hypholoma is so closely related to the tufted hypholoma, Hypholoma aggregatum Pk., that it is considered a mere variety of it. It differs from it in its larger size, in the entire absence of scales or spots from its cap and in the broader attachment of its gills to the stem. It is also related to the European forest hypholoma, Hypholoma silvestre Gill., from which it differs in the color of the cap and in the absence from the cap of the broad brown or blackish scales of that species. It has some points of resemblance to Candolle's hypholoma, H. candolleanum, and to the dingy white hypholoma, H. leucotephrum, but it is to be kept separate from these because it is not hygrophanous.

The cap is quite white when young, but with advancing age it assumes a more dingy or grayish hue and gradually becomes more broadly convex. Its surface is furnished with white silky fibrils which are suggestive of its varietal name. The margin is often wavy or irregular because of its crowded mode of growth and before maturity it is usually appendiculate with fragments of the veil. The flesh is white but when the cap is cut through vertically a narrow watery streak may sometimes be seen along the part next the gills. The gills are concealed at first by the copious white flocculent or webby veil. They are

then white, but after exposure they soon become brownish and finally assume the color of the spores, which is brown tinged with purple. They are not at all or only slightly rounded at the stem and the edges in the mature plant often remain white. The stems are rather long and flexuous, hollow, white, marked with short parallel longitudinal lines at the top and sometimes with reddish stains at the base.

The cap is 1.5–3.5 inches broad; the stem 3–5 inches long and 2–5 lines thick. The plants grow singly or in tufts about old stumps and appear in September. They are very good as an edible mushroom. The typical form has also been found to be edible by one of my correspondents but I have had no opportunity to try it.

Boletus bicolor Pk.

TWO COLORED BOLETUS

PLATE 81, FIG. 6–11

Pileus convex, firm, becoming softer with age, dry, glabrous or merely pruinose tomentose, dark red becoming paler and sometimes spotted or stained with yellow when old, flesh yellow, not at all or but slightly changing to blue where wounded, taste mild; tubes nearly plane in the mass, adnate, short and yellow when young, longer and ochraceous when mature, their mouths small, angular or subrotund, slowly and slightly changing to blue where wounded; stem nearly equal, firm, solid, dark red, usually yellow at the top; spores pale ochraceous brown, narrowly elliptic or subfusiform, .0004–.0005 of an inch long, .00016–.0002 broad.

The two colored boletus has the cap and stem dark red or Indian red and the tubes and flesh yellow, which is suggestive of the name applied to it. The cap becomes paler in color and softer in texture as it becomes older, and it often becomes yellowish on the margin and spotted or stained with yellow elsewhere. The surface sometimes cracks in small areas revealing the yellow flesh beneath. The tubes are at first short and bright yellow but they become longer and assume orchraceous hues as they grow older. The mouths are small and the dis-

sepiments slowly assume a blue color where wounded. The stem varies in length but it is generally nearly equal in thickness in all its parts. It is colored like the cap except at the top where it is generally yellow like the tubes. It is solid as in most boleti and by this character it may be distinguished from the closely related European Boletus barlae.

The cap is 2–4 inches broad; the stem 1–3 inches long and 4–6 lines thick. This boletus grows in thin woods or open places and seems to prefer localities where chestnut trees grow. It may be found from July to September. When properly cooked it is tender and has a fine flavor and merits a place among first class mushrooms.

Boletus pallidus Frost

PALE BOLETUS

PLATE 81, FIG. 1–5

Pileus fleshy, convex becoming nearly plane or slightly concave above by the elevation of the margin, soft, dry, glabrous, whitish, grayish or brownish, sometimes tinged with red, flesh white; tubes nearly plane in the mass when young, adnate or slightly depressed around the stem, pale yellow or whitish, usually tinged with green, becoming darker with age, their mouths small, subrotund, the dissepiments assuming bluish hues where wounded; stem commonly rather long, straight or flexuous, solid, equal or slightly thickened at the base, glabrous, whitish, sometimes streaked with brown and tinged with red within; spores pale ochraceous brown tinged with green, subfusiform, .0004–.0005 of an inch long, .0002–.00025 broad.

The pale boletus or pallid boletus is appropriately named. Its cap and stem are not a clear white but just enough shaded with brown to suggest the term pale. Whitish, dingy white, smoky white, grayish or grayish white are expressive of its varying hues. There is sometimes a slight reddish tint in the cap. Its color is apt to become darker in drying. Its surface is dry and smooth or nearly so and the cuticle is sometimes marked by fine cracks, specially on the margin. These reveal the white flesh beneath. The tubes generally form a nearly

plane surface below, but sometimes this is distinctly concave in the young plant and convex in the mature one. They are often slightly depressed around the stem and then their mouths in the depressed part are usually a little larger than elsewhere. Their color is a very pale yellow or greenish yellow and they change to bluish where wounded or bruised. The stem is generally rather long and flexuous though sometimes it is short and straight. It is solid, smooth and whitish, but sometimes streaked with brown and tinged with red within.

The cap is 2-4 inches broad; the stem 2-5 inches long and 3-8 lines thick. The plants inhabit thin woods, groves and open places, and may be found from July to September. This is an excellent boletus for the table, is easily recognized and generally free from the attacks of insect larvae. This and the preceding species, together with the red cracked boletus, B. chrysenteron, show how unreliable is the rule that directs the avoidance of all boleti whose flesh or tubes change to blue where wounded.

Boletus ornatipes Pk.

ORNATE STEMMED BOLETUS

PLATE 80, FIG. 1-5

Pileus fleshy, firm, hemispheric becoming convex or nearly plane, minutely tomentose or glabrous, gray, grayish brown or yellowish brown, flesh yellow; tubes nearly plane in the mass when young, convex when old, adnate or slightly depressed around the stem, golden yellow, their mouths small, subrotund; stem equal or nearly so, solid, firm, distinctly and beautifully reticulated, yellow without and within; spores ochraceous brown, oblong or subfusiform, .00045-.00055 of an inch long; .00016-.0002 broad.

The attractive characters of the ornate stemmed boletus and those by which it may readily be recognized are the beautifully reticulated yellow stem, yellow tubes and clean dry grayish or brownish cap. The cap is hemispheric in the young plant, broadly convex or nearly plane in the mature one. It is dry

and smooth or nearly so and variable in color. The prevailing colors are gray and brown variously blended and often intermingled with yellow. It may be brown when young fading to grayish brown or yellowish brown when mature. The flesh is yellow but this also varies in depth of hue. The tubes sometimes form a plane surface beneath the cap but sometimes those around the stem are a little shorter than the rest thereby forming a depression in the surface. They have a clear yellow color which becomes darker with age. They do not assume blue tints where bruised or wounded. The stem is usually of equal thickness throughout. It is solid and reticulated with a network of ridges from top to bottom. Its color both externally and internally is yellow.

The cap is 2–5 inches broad; the stem 2–4 inches long and 4 to 6 lines thick. This boletus grows in thin woods or in open places. It is sometimes found on earth banks by roadsides. It appears during July and August. It is clean, sound and well flavored.

Boletus eximius Pk.

SELECT BOLETUS

PLATE 80, FIG. 6–12

Pileus fleshy, very compact and globose or hemispheric when young, becoming softer and somewhat paler with age, dry, glabrous or nearly so, purplish brown or chocolate color, flesh brittle, gray or purplish gray varied with darker dots, taste mild; tubes in the young plant short stuffed or closed, concave or nearly plane in the mass, colored nearly like the pileus, becoming longer and sometimes convex in the mass when older, adnate, their mouths minute, rotund; stem equal or nearly so, sometimes slightly ventricose, solid, scurfy, colored like or a little paler than the pileus, purplish gray within; spores brownish ferruginous, oblong, .00045–.0006 of an inch long, .00016–.00025 broad.

The select boletus is a large robust species nearly of one color throughout, quite constant in its characters and easily recognized. It has a purplish brown or chocolate color which

sometimes becomes a little paler with age. The flesh has a grayish hue tinged with purple and in the cap varied with darker dots. It is very firm and brittle when young but becomes softer with age. It is so peculiar in color and so unlike any of our other species that it is easily recognized and needs no extended description.

The cap is 3–10 inches broad; the stem 2–4 inches long and 6–15 lines thick. It grows in woods or their borders and appears in July and August. It is one of the best edible species but unfortunately it is not abundant. Its large size however, may compensate to some extent for its deficiency in numbers. Sometimes a single large specimen is found growing entirely alone.

Bovista plumbea Pers.

LEAD COLORED BOVISTA

PLATE 81, FIG. 12–19

Peridium globose or nearly so, 6–14 lines in diameter, smooth, double, the exterior coat fragile, separable from the inner, breaking up and falling away at maturity, white when young, the inner thin, papery but tough, smooth, plumbeous when old, paler when first exposed, rarely becoming blackish with age, mouth apical, small; threads of the capillitium branched, free, the ultimate branches long, slender, gradually tapering to a point, purplish brown; spores brown or purplish brown, subglobose, .0002–.00025 of an inch long, nearly or quite as broad, their pedicels slender, hyaline, persistent, two to three times as long as the spores.

The lead colored bovista is a small globular puffball found growing on the ground in grassy places or in pastures. It appears both in autumn and in spring or early summer. It varies in size from half an inch to one inch in diameter. When young it is white both externally and internally, and while in this condition it is available for food. It should be discarded if the flesh has begun to lose its white color. As it approaches maturity the exterior coat is easily broken and removable in flakes or fragments. Its removal reveals the pale papery but

tough and flexible inner membrane or peridium. With advancing age this assumes a dull grayish blue or leaden hue and opens by a small aperture at the top for the escape of the spores. Any sudden pressure applied to it at this time will cause the ejection of a mass of its spores in little smokelike puffs as in other puffballs. Occasionally old specimens are found in which the inner peridium is almost black. The small size, peculiar color and distinctly double coat of the immature plant are characters which make this bovista easily recognizable. Its flavor is much more agreeable than that of many of the small species of the genus Lycoperdon.

EXPLANATION OF PLATES

PLATE K

Clitocybe regularis Pk.

REGULAR CLITOCYBE

FIG.
1 Immature plant
2 Mature plant with convex cap
3 Mature plant with nearly plane cap
4 Vertical section of an immature plant
5 Vertical section of the upper part of a mature plant
6 Transverse section of a stem of a mature plant
7 Four spores × 400

Clitocybe subconcava Pk.

SUBCONCAVE CLITOCYBE

8 Plant with the cap moist
9, 10 Two plants with caps dry
11 Vertical section of the upper part of a plant
12 Transverse section of a stem
13 Four spores × 400

Hydnum umbilicatum Pk.

UMBILICATE HYDNUM

14 Immature plant showing the upper surface of the cap
15, 16 Two mature plants showing both surfaces of the cap
17 Vertical section of the upper part of a plant
18 Four spores × 400

Boletus multipunctus Pk.

MANY DOTTED BOLETUS

FIG.

19 Plant with a convex cap
20 Plant with the cap nearly plane
21 Vertical section of the upper part of a plant
22 Four spores × 400

PLATE L

Cortinarius obliquus Pk.

OBLIQUE BULBED CORTINARIUS

1 Immature plant
2 Mature plant
3 Vertical section of the upper part of an immature plant
4 Vertical section of the upper part of a mature plant
5 Four spores × 400

Cortinarius submarginalis Pk.

SUBMARGINED CORTINARIUS

6 Immature plant
7 Mature plant
8 Vertical section of the upper part of an immature plant
9 Vertical section of the upper part of a mature plant
10 Four spores × 400

Helvella adhaerens Pk.

ADHERING MARGINED HELVELLA

11 Small pale plant
12 Large plant of darker color
13 Vertical section of a plant
14 A paraphysis and an ascus containing spores × 400
15 Four spores × 400

PLATE 77

Tricholoma russula (Schaeff.) Fr.

REDDISH TRICHOLOMA

1 Immature plant
2 Mature plant with convex cap
3 Mature plant with cap nearly plane
4 Vertical section of the upper part of a plant
5 Four spores × 400

Hygrophorus laurae Morg.

LAURA'S HYGROPHORUS

FIG.
6 Immature plant
7 Mature plant with umbonate cap
8 Mature plant with cap nearly plane
9 Plant showing the colors assumed in drying
10 Vertical section of the upper part of an immature plant
11 Vertical section of the upper part of a mature plant
12 Four spores × 400

var. unicolor

13 Immature plant
14 Mature plant

PLATE 78

Clitopilus micropus Pk.

SHORT STEMMED CLITOPILUS

1 Immature plant
2 Immature plant with the margin of the cap slightly zoned
3-6 Mature plants with caps differing in form
7 Mature plant with lobed cap and eccentric stem
8 Vertical section of the upper part of an immature plant
9 Vertical section of the upper part of a mature plant with solid stem
10 Vertical section of the upper part of a mature plant with hollow stem
11 Transverse section of a hollow stem
12 Four spores × 400

Clitopilus abortivus B. & C.

ABORTIVE CLITOPILUS

13 Immature plant
14 Mature plant with convex cap
15 Mature plant with the cap centrally depressed
16 Vertical section of the upper part of an immature plant
17 Vertical section of the upper part of a mature plant
18 Four spores × 400
19 Two abortive plants

PLATE 79

Pholiota squarrosa Mull.

SCALY PHOLIOTA

FIG.

1 Cluster of three young plants
2 Immature plant
3 Mature plant
4 Vertical section of the upper part of an immature plant
5 Vertical section of the upper part of a mature plant
6 Transverse section of a stem
7 Four spores × 400

Hypholoma aggregatum sericeum Pk.

SILKY HYPHOLOMA

8 Cluster of four young plants
9 Immature plant
10 Mature plant
11 Vertical section of the upper part of an immature plant
12 Vertical section of the upper part of a mature plant
13 Transverse section of a stem
14 Four spores × 400

PLATE 80

Boletus ornatipes Pk.

ORNATE STEMMED BOLETUS

1 Immature plant
2 Mature plant with convex cap
3 Mature plant with cap more expanded
4 Vertical section of the upper part of a plant
5 Four spores × 400

Boletus eximius Pk.

SELECT BOLETUS

6 Immature plant
7 Mature plant with convex cap
8 Mature plant with cap more expanded
9 Mature plant of larger size
10 Vertical section of the upper part of an immature plant
11 Vertical section of the upper part of a mature plant
12 Four spores × 400

PLATE 81

Boletus pallidus Frost

PALE BOLETUS

FIG.

1 Immature plant

2 Mature plant with convex cap

3 Mature plant with cap more expanded

4 Vertical section of the upper part of a plant

5 Four spores × 400

Boletus bicolor Pk.

TWO COLORED BOLETUS

6 Young plant

7 Immature plant

8 Mature plant

9 Vertical section of the upper part of an immature plant

10 Vertical section of the upper part of a mature plant

11 Four spores × 400

Bovista plumbea Pers.

LEAD COLORED BOVISTA

12, 13 Immature plants differing in size

14 Plant nearly mature showing inner coat in three places

15 Mature plant with part of outer coat remaining at the base

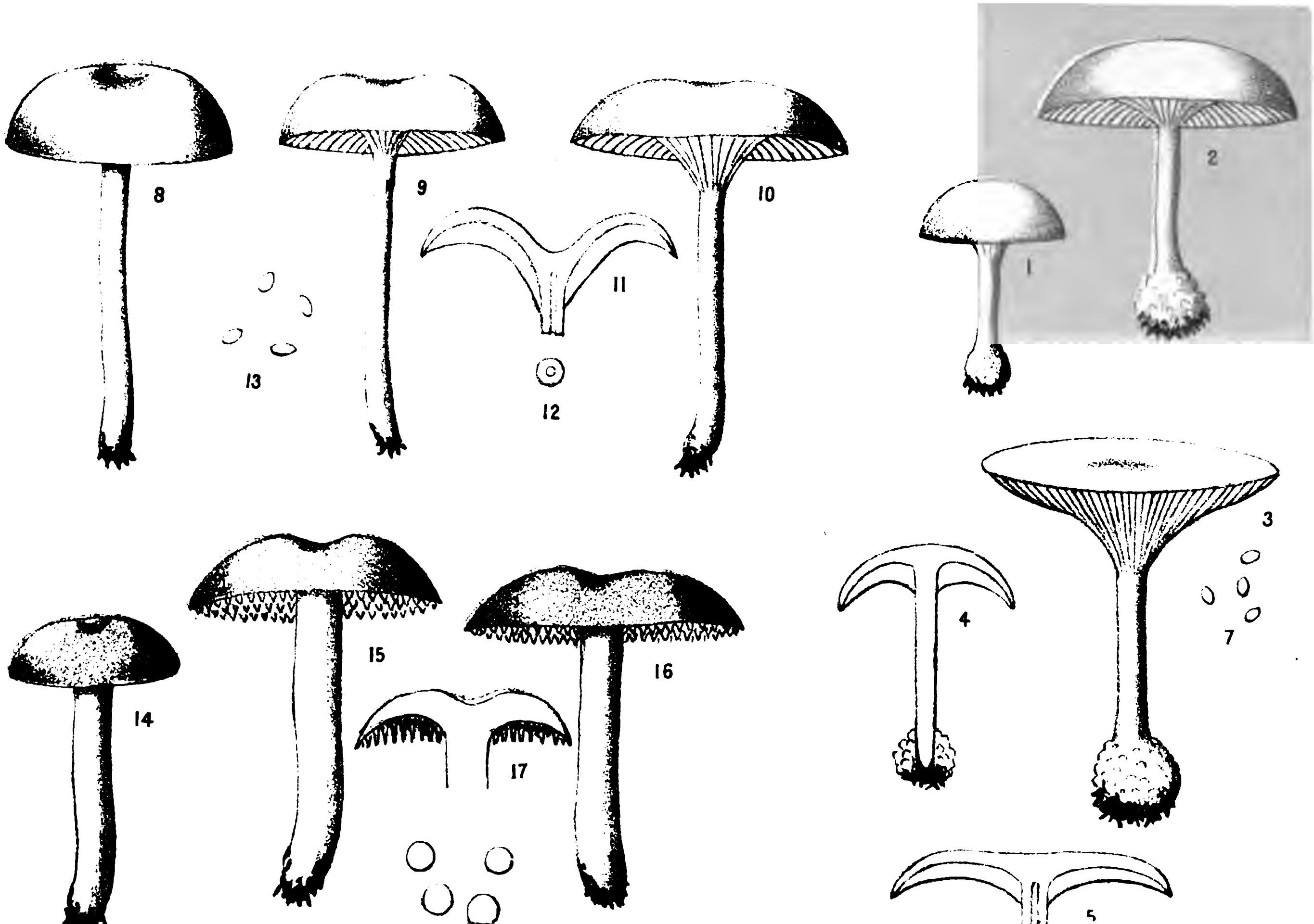
16 Mature plant with outer coat wholly gone

17 Small mature plant with inner coat nearly black

18 Part of a branching thread of the capillitium × 400

19 Four spores and their pedicels × 400

FUNGI.



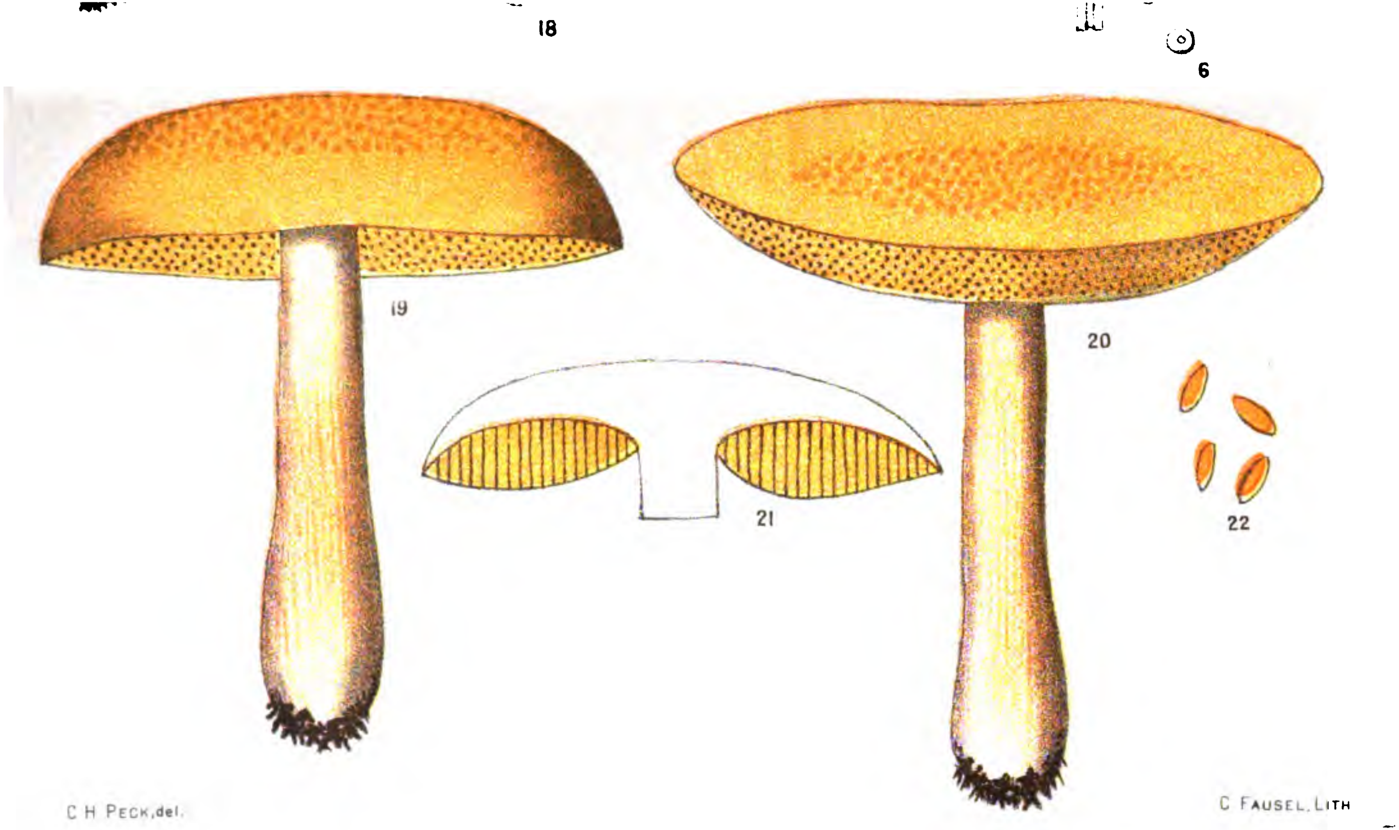


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Fig. 1-7 **CLITOCYBE REGULARIS** Pk.
REGULAR CLITOCYBE

Fig. 8-13 **CLITOCYBE SUBCONCAVA** Pk.
SUBCONCAVE CLITOCYBE

Fig. 14-18 **HYDNUM UMBILICATUM** Pk.
UMBILICATE HYDNUM

Fig. 19-22 **BOLETUS MULTIPUNCTUS** Pk.
MANY DOTTED BOLETUS

FUNGI.

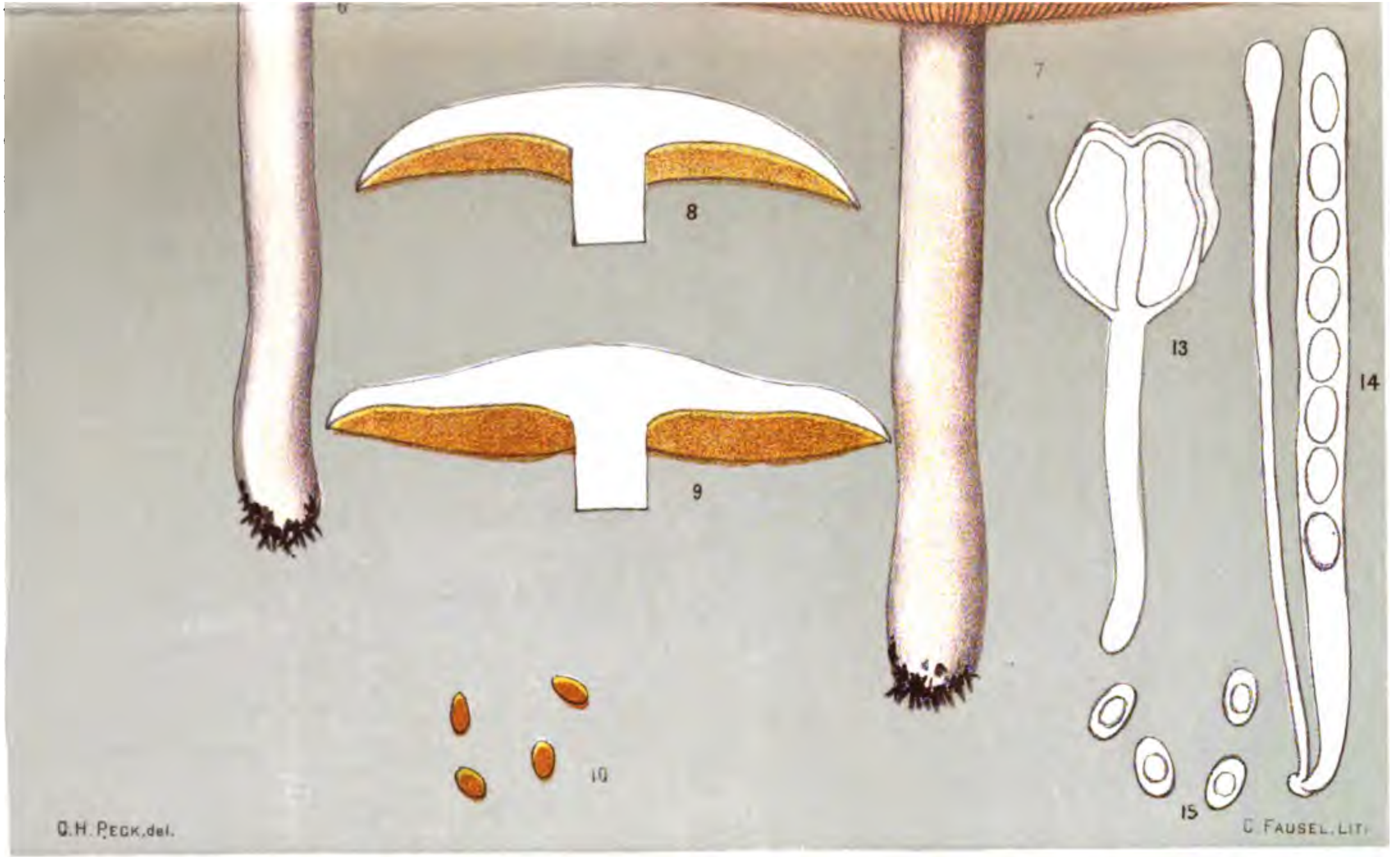

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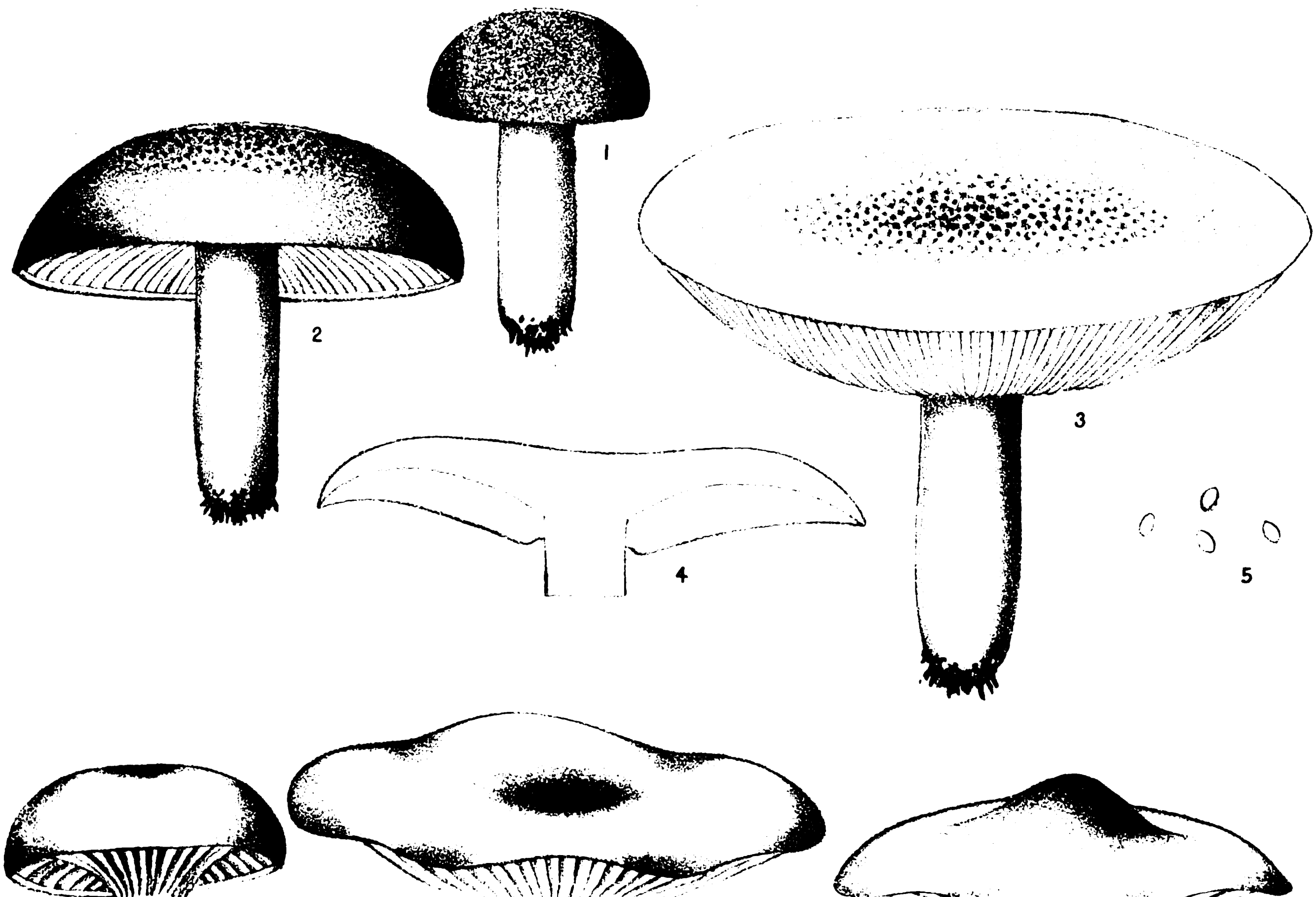
Fig. 1-5 **CORTINARIUS OBLIQUUS** Pk.
OBLIQUE BULBED CORTINARIUS

Fig. 6-10 **CORTINARIUS SUBMAGINALIS** Pk.,
SUBMARGINED CORTINARIUS

Fig. 11-15 **HELVELLA ADHAERENS** Pk.
ADHERING MARGINED HELVELLA

EDIBLE FUNGI.



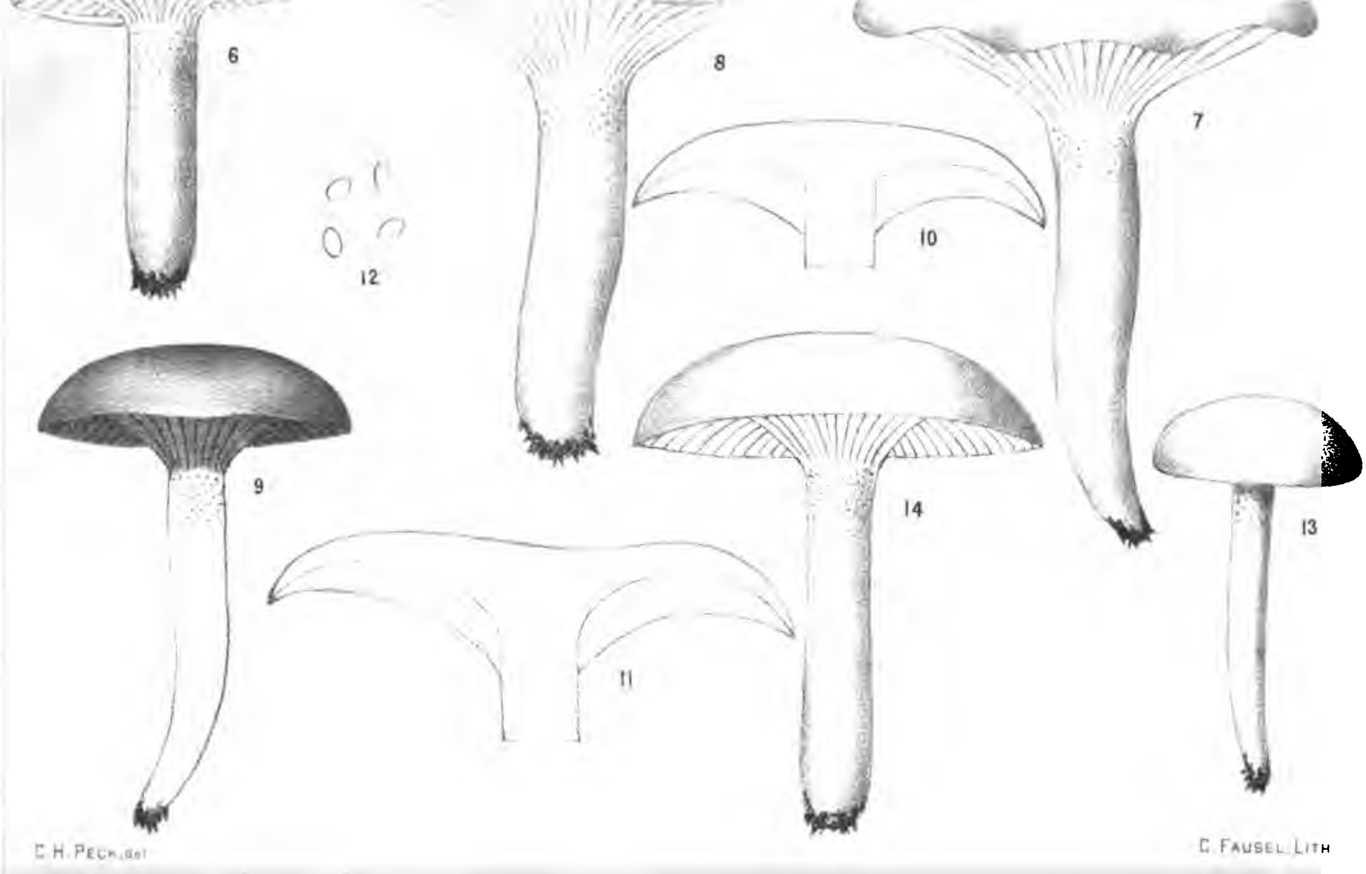


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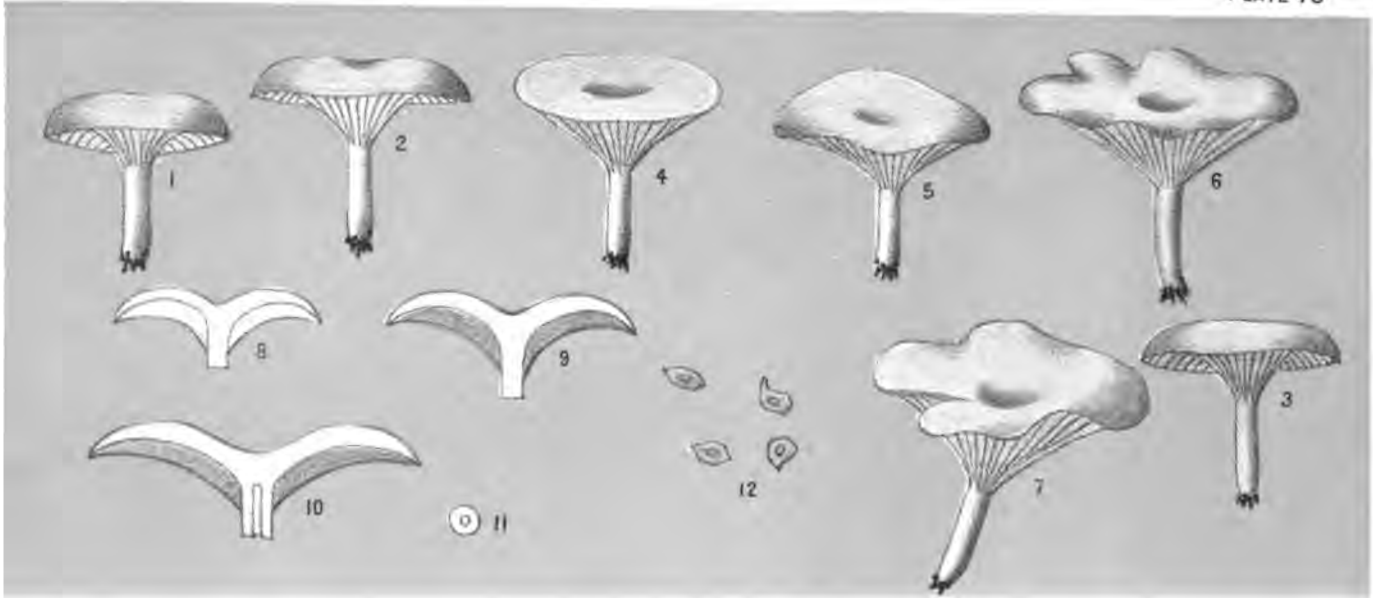
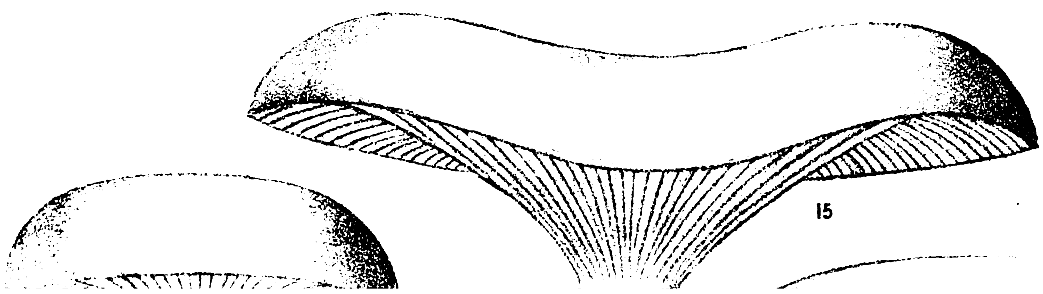
Fig. 1-5 **TRICHOLOMA RUSSULA** (Schaeff) Fr.
REDDISH TRICHOLOMA

Fig. 6-14 **HYGROPHORUS LAURAE** Morg.
LAURA'S HYGROPHORUS

EDIBLE FUNGI.





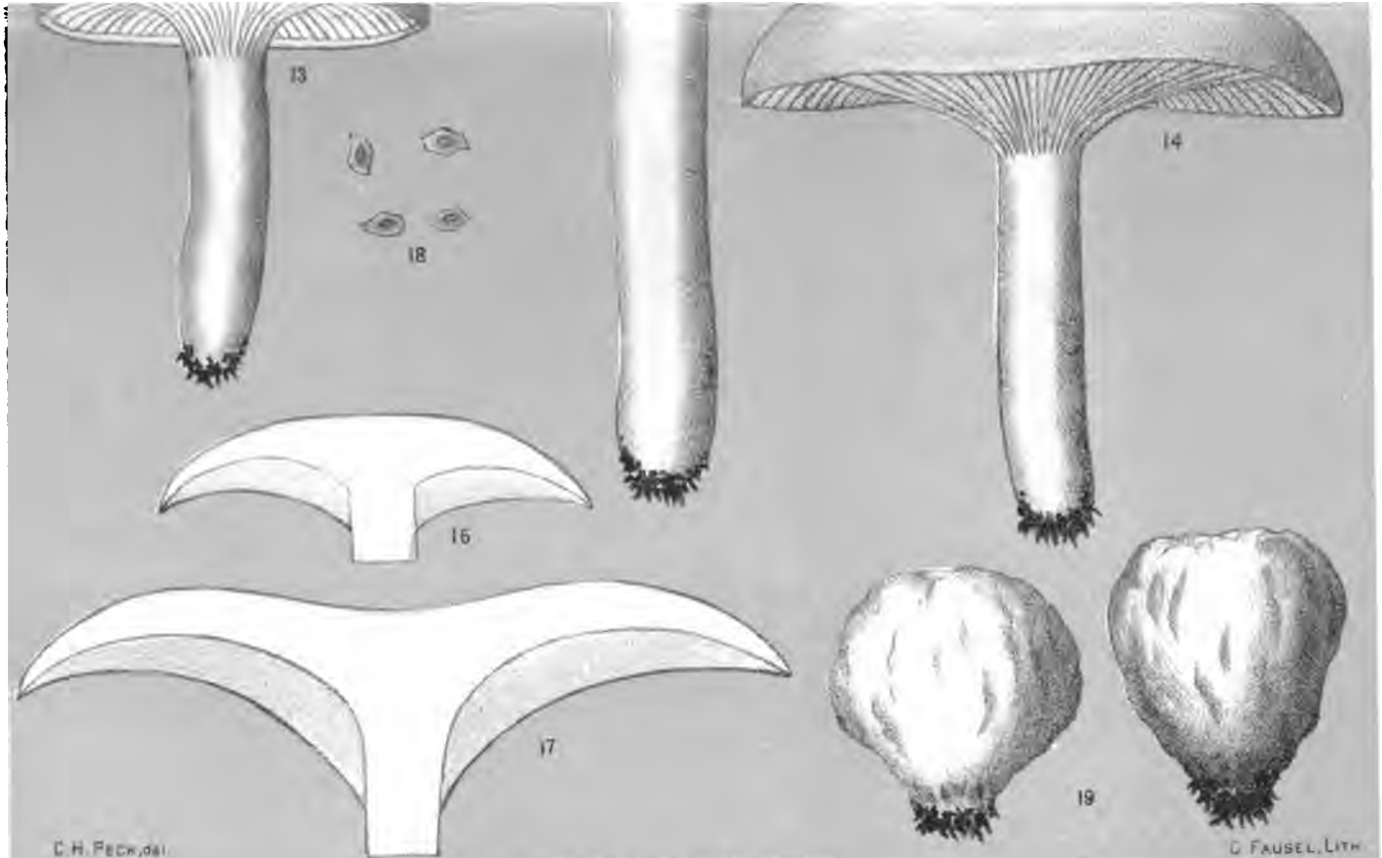


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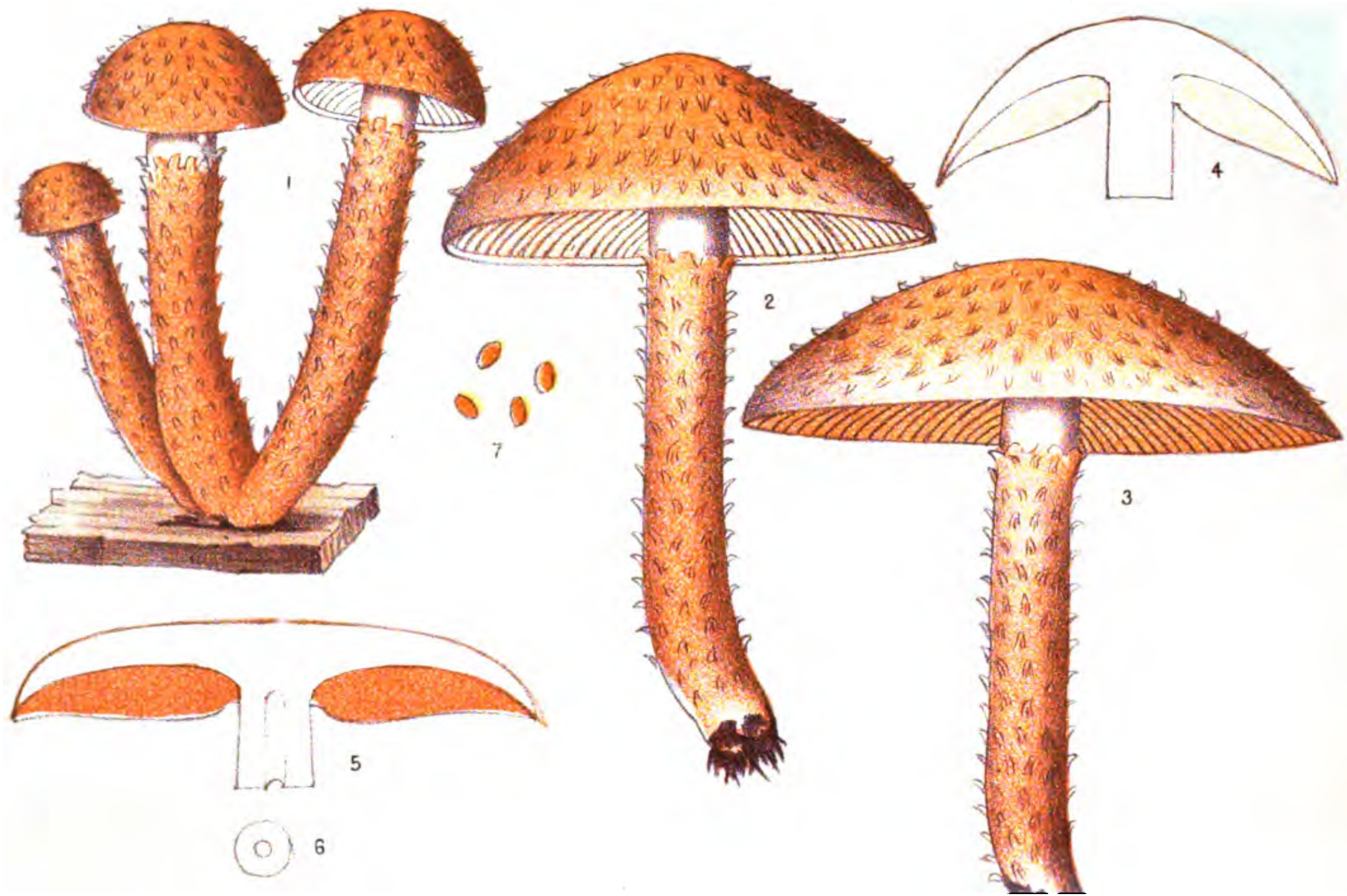
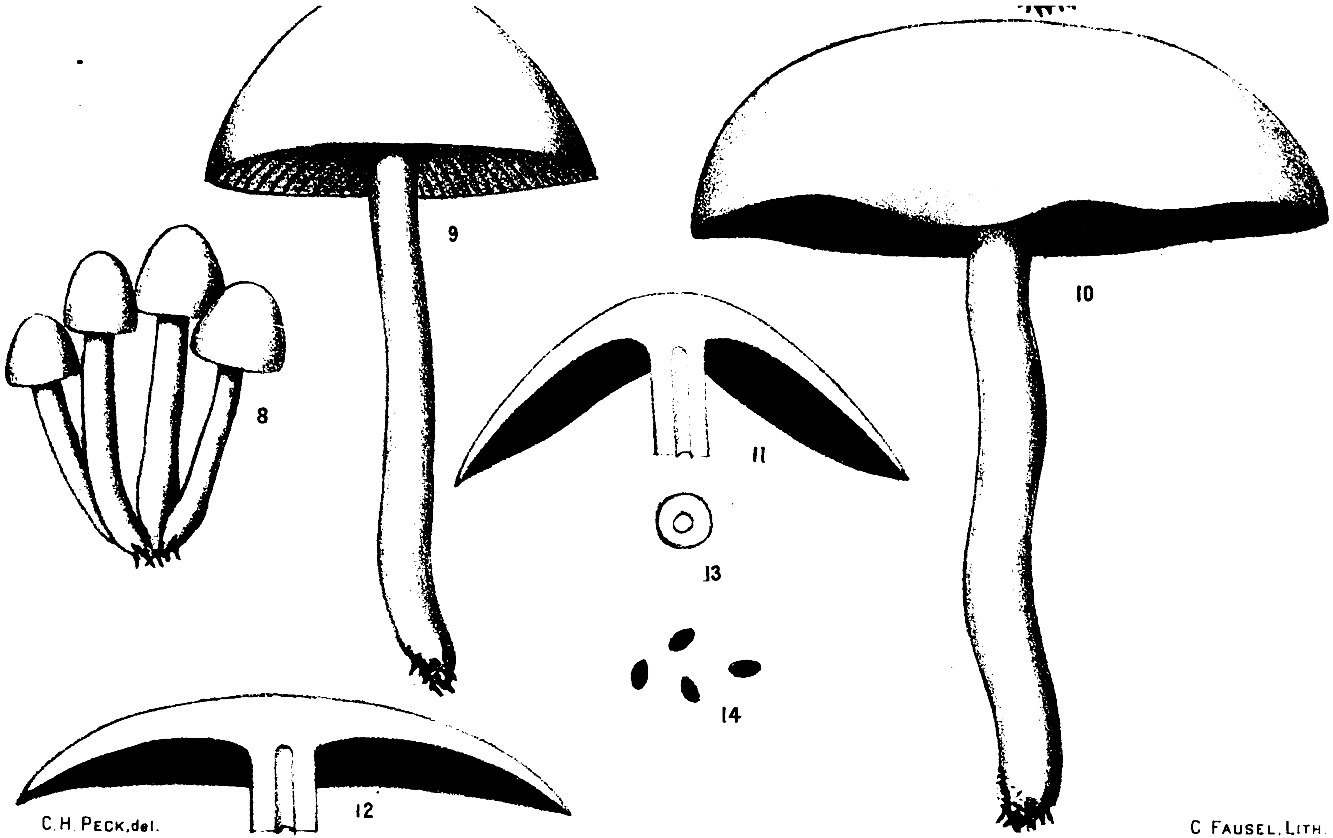
Fig. 1-12 **CLITOPILUS MICROPUS** Pk.
SHORT STEMMED CLITOPILUS

Fig. 13-19 **CLITOPILUS ABORTIVUS** B. & C.
ABORTIVE CLITOPILUS

EDIBLE FUNGI.





C. H. Peck, del. C. Fausel, Lith.

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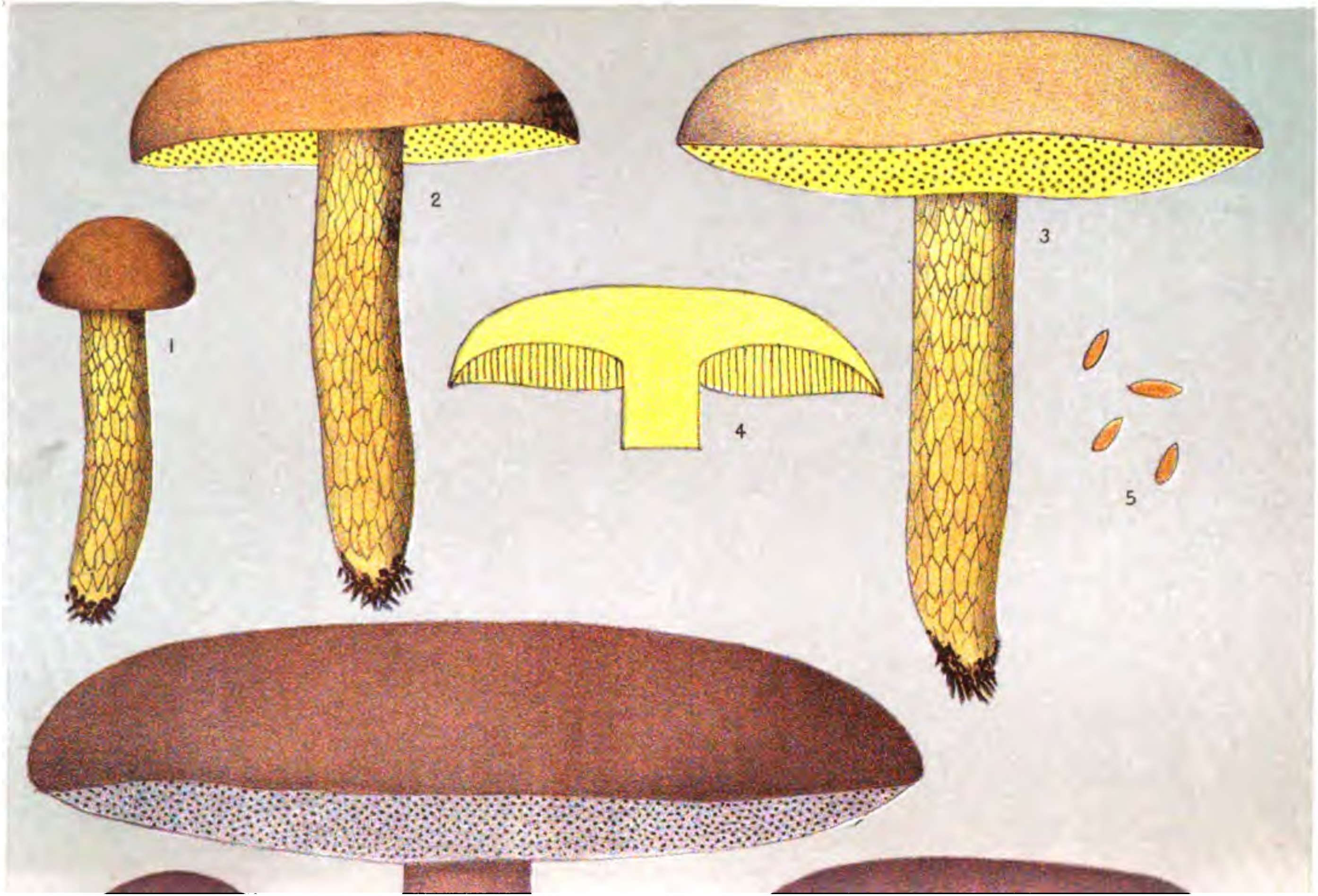
FIG. 1-7 **PHOLIOTA SQUARROSA** MULL.
SCALY PHOLIOTA

FIG. 8-14 **HYPHOLOMA AGGREGATUM SERICEUM** PK.
SILKY HYPHOLOMA

EDIBLE FUNGI.



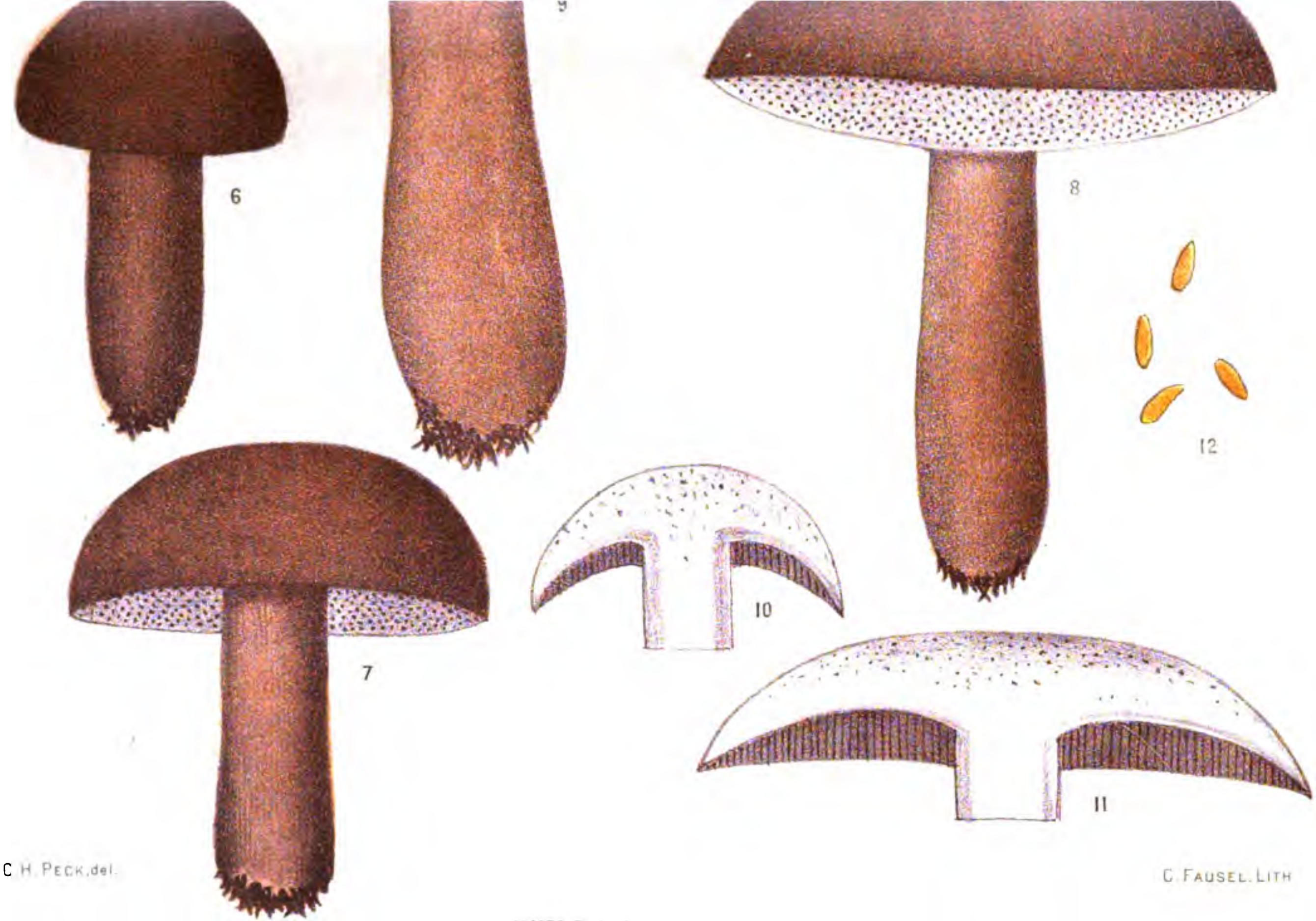


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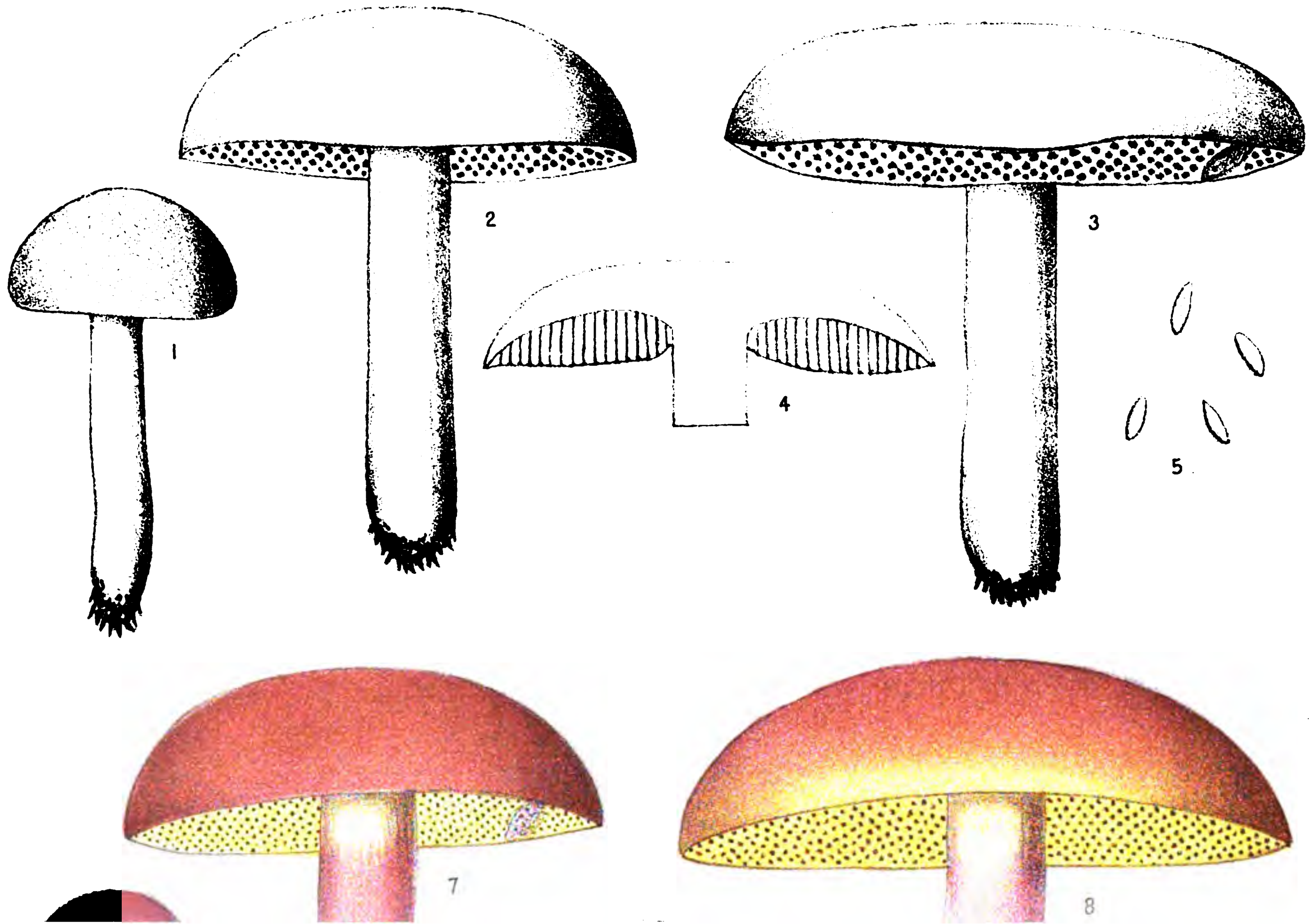
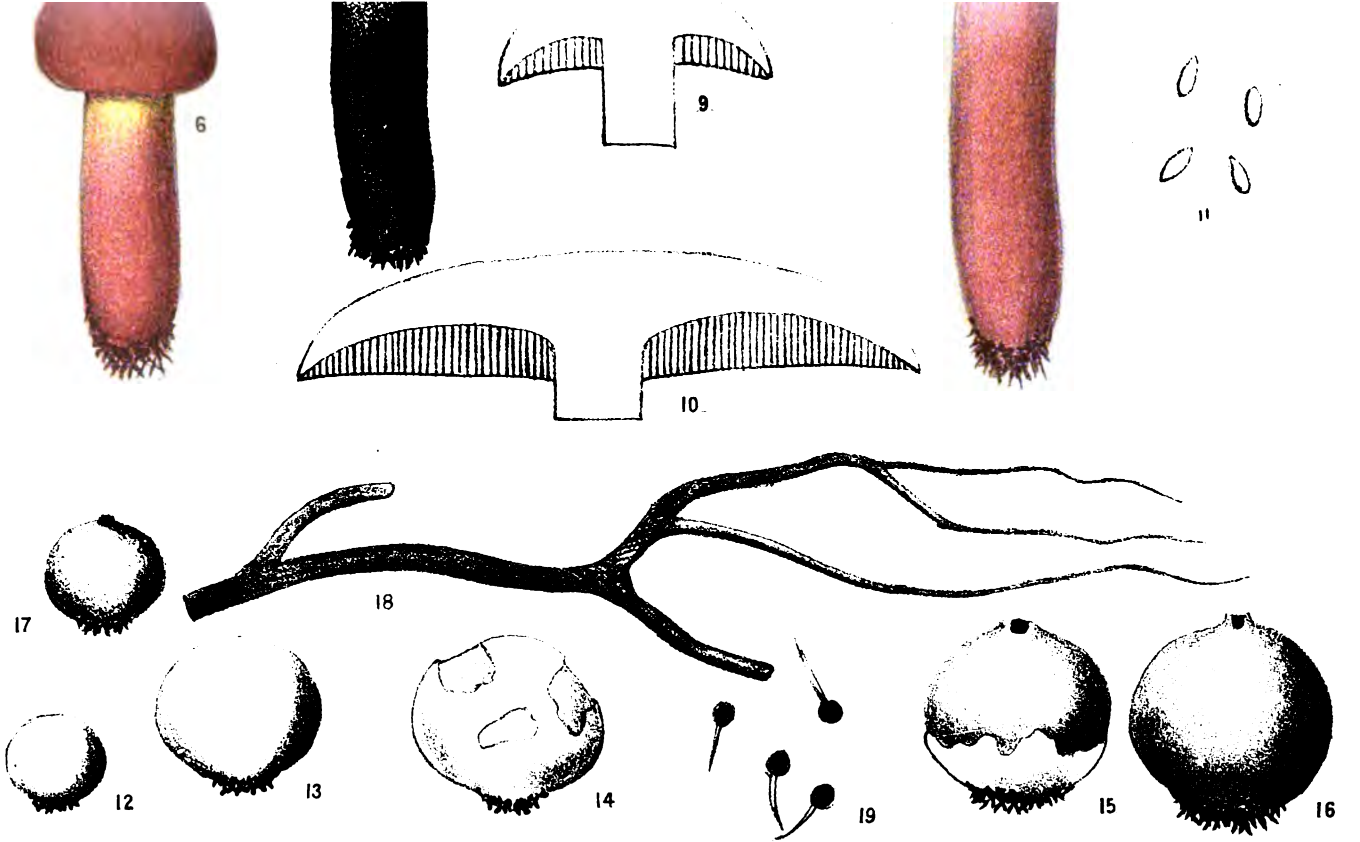
Fig. 1-5 **BOLETUS ORNATIPES** Pk.
ORNATE STEMMED BOLETUS

Fig. 6-12 **BOLETUS EXIMIUS** Pk.
SELECT BOLETUS

EDIBLE FUNGI.





C H PECK, del.

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FIG. 1-5 **BOLETUS PALLIDUS** FROST
PALE BOLETUS

FIG. 6-11 **BOLETUS BICOLOR** PK.
TWO COLORED BOLETUS

FIG. 12-19 **BOVISTA PLUMBEA** PERS.
LEAD COLORED BOVISTA

INDEX

The superior figures tell the exact place on the page in ninths; e. g. 961^{3} means page 961 beginning in the third ninth of the page, i. e. about one third of the way down.

University of the State of New York

New York State Museum

MUSEUM PUBLICATIONS

Any of the University publications will be sold in lots of 10 or more at 20% discount. When sale copies are exhausted, the price for the few reserve copies is advanced to that charged by secondhand booksellers to limit their distribution to cases of special need. Such prices are inclosed in brackets.

All publications are in paper covers, unless binding is specified.

Museum annual reports 1847–date. *All in print to 1892, 50c a volume, 75c in cloth; 1892–date, 75c, cloth.*

These reports are made up of the reports of the director, geologist, paleontologist, botanist and entomologist, and museum bulletins and memoirs, issued as advance sections of the reports.

Geologist's annual reports 1881–date. Rep'ts 1, 3-13, 17–date, O.; 2, 14–16, Q.

The annual reports of the early natural history survey, 1836-42 are out of print.

Reports 1-4, 1881-84 were published only in separate form. Of the 5th report 4 pages were reprinted in the 39th museum report, and a supplement to the 6th report was included in the 40th museum report. The 7th and subsequent reports are included in the 41st and following museum reports, except that certain lithographic plates in the 11th report (1891), 13th (1893) are omitted from the 45th and 47th museum reports.

Separate volumes of the following only are available.

Report	*Price*	*Report*	*Price*	*Report*	*Price*
12 (1892)	$.50	16	$1	19	$.40
14	.75	17	.75	20	.50
15	1	18	.75		

In 1898 the paleontologic work of the State was made distinct from the geologic and will hereafter be reported separately.

Paleontologist's annual reports 1899–date.

See fourth note under Geologist's annual reports.

Bound also with museum reports of which they form a part. Reports for 1899 and 1900 may be had for 20c each. Beginning with 1901 these reports will be issued as bulletins.

Botanist's annual reports 1869–date.

Bound also with museum reports 22–date of which they form a part; the first botanist's report appeared in the 22d museum report and is numbered 22.

Reports 22-41, 48, 49, 50 and 52 (Museum bulletin 25) are out of print; 42-47 are inaccessible. Report 51 may be had for 40c; 53 for 20c; 54 for 50c. Beginning with 1901 these reports will be issued as bulletins.

Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have been published in volumes 1 and 3 of the 48th museum report and in volume 1 of the 49th, 51st and 52d reports. The botanical part of the 51st is available also in separate form. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged, and combined with others more recently prepared and constitute Museum memoir 4.

Entomologist's annual reports on the injurious and other insects of the State of New York 1882–date.

Bound also with museum reports of which they form a part. Beginning with 1898 these reports have been issued as bulletins. Reports 3-4 are out of print, other reports with prices are:

Report	*Price*	*Report*	*Price*	*Report*	*Price*
1	$.50	8	$.25	13	$.10
2	.30	9	.25	14 (Mus. bul. 23)	.20
5	.25	10	.35	15 (" 31)	.15
6	.15	11	.25	16 (" 36)	.25
7	.20	12	.25	17 (" 53)	.30

Reports 2, 8-12 may also be obtained bound separately in cloth at 25c in addition to the price given above.

Museum bulletins 1887–date. O. *To advance subscribers, $2 a year or 50c a year for those of any one division:* (1) *geology, including economic geology, general zoology, archeology and mineralogy,* (2) *paleontology,* (3) *botany,* (4) *entomology.*

Bulletins are also found with the annual reports of the museum as follows:

Bulletins	*Report*	*Bulletins*	*Report*	*Bulletins*	*Report*
12–15	48, v. 1	20–25	52, v. 1	35–36	54, v. 2
16–17	50 "	26–31	53 "	37–44	" v. 3
18–19	51 "	32–34	54 "	45–48	" v. 4

The letter and figure in parenthesis after the bulletin number indicate the division and series number. G=geology, EG=economic geology, Z=general zoology, A=archeology, M=mineralogy, P=paleontology, B=botany, E=entomology, Misc=miscellaneous.

Volume 1. *6 nos. $1.50 in cloth*

1 (Z1) Marshall, W: B. Preliminary List of New York Unionidae. 20p. Mar. 1892. *5c.*

2 (B1) Peck, C: H. Contributions to the Botany of the State of New York. 66p. 2pl. May 1887. [*35c*]

3 (EG1) Smock, J: C. Building Stone in the State of New York. 152p. Mar. 1888. *Out of print.*

4 (M1) Nason, F. L. Some New York Minerals and their Localities. 20p. 1pl. Aug. 1888. *5c.*

5 (E1) Lintner, J. A. White Grub of the May Beetle. 32p. il. Nov. 1888. *10c.*

6 (E2) ——— Cut-worms. 36p. il. Nov. 1888. *10c.*

Volume 2. *4 nos.* [*$1.50*] *in cloth*

7 (EG2) Smock, J: C. First Report on the Iron Mines and Iron Ore Districts in New York. 6+70p. map. June 1889. *Out of print.*

8 (B2) Peck, C: H. Boleti of the United States. 96p. Sep. 1889. [*50c*]

9 (Z2) Marshall, W: B. Beaks of Unionidae Inhabiting the Vicinity of Albany, N. Y. 24p. 1pl. Aug. 1890. *10c.*

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—— Dictyonine Hexactinellid Sponges from the Upper Devonic of New York.

—— The Water Biscuit of Squaw Island, Canandaigua Lake, N. Y.

Simpson, G: B. Preliminary Descriptions of New Genera of Paleozoic Rugose Corals.

Loomis, F: B. Siluric Fungi from Western New York.

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Clarke, J: M. Limestones of Central and Western New York Interbedded with Bituminous Shales of the Marcellus Stage.
Wood, Elvira. Marcellus Limestones of Lancaster, Erie Co. N. Y.
Clarke, J: M. New Agelacrinites.
—— Value of Amnigenia as an Indicator of Fresh-water Deposits during the Devonic of New York, Ireland and the Rhineland.

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Eckel, E. C. Serpents of Northeastern United States.
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Dickinson, H. T. Bluestone Quarries in New York. *In press.*

Clarke, J: M. Catalogue of Type Specimens of Paleozoic Fossils in the New York State Museum. *In press.*

Museum memoirs 1889–date. Q.

1 Beecher, C: E. & Clarke, J: M. Development of some Silurian Brachiopoda. 96p. 8pl. Oct. 1889. *Out of print.*

2 Hall, James & Clarke, J: M. Paleozoic Reticulate Sponges. 350p. il. 70pl. Oct. 1899. *$1, cloth.*

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v. 8 pt1 Introduction to the Study of the Genera of the Paleozoic Brachiopoda. 16+367p. 44pl. 1892. *$2.50.*

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Museum handbooks 1893–date. 7½x12½ cm.
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H16 Entomology. 8p. *Out of print.*

H17 Geology. *In preparation.*

Maps. Merrill, F: J. H. Economic and Geologic Map of the State of New York. 59x67 cm. 1894. Scale 14 miles to 1 inch. *Out of print.*
New edition in preparation.
Printed also with Museum bulletin 15 and the 48th museum report, v. 1.

—— Geologic Map of New York. 1901. Scale 5 miles to 1 inch. *In atlas form $3; mounted on rollers $5. Lower Hudson sheet 60c.*

The lower Hudson sheet, geologically colored, comprises Rockland, Orange, Dutchess, Putnam, Westchester, New York, Richmond, Kings, Queens and Nassau counties, and parts of Sullivan, Ulster and Suffolk counties; also northeastern New Jersey and part of western Connecticut.

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Bulletin 55

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METALLIC IMPLEMENTS

OF THE

NEW YORK INDIANS

BY

WILLIAM M. BEAUCHAMP S.T.D.

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Bulletin 55

METALLIC IMPLEMENTS

OF THE

NEW YORK INDIANS

LIST OF AUTHORITIES ON METALLIC IMPLEMENTS

The following works are referred to in the bulletin by the abbreviations in the left margin.

Abbott — **Abbott, C. C.** Primitive industry. Salem (Mass.) 1881.

Abbott. Copper. — ——— Use of copper by the Delaware Indians. (*see* American naturalist, 1885, 19:774)

Barber — **Barber, Edwin A.** Antiquity of the tobacco pipe in Europe. (*see* American antiquarian, 1879, 2:1)

Beauchamp — **Beauchamp, W: M.** The good hunter and the Iroquois medicine. (*see* Journal of American folk-lore, 1901, 14:153)

Belknap — **Belknap, Jeremy.** Biographies of the early discoverers of America. 1798.
New York reprint n. d.

Boyle — **Boyle, David.** Notes on primitive man in Ontario. Appendix to report of minister of education for Ontario. Toronto 1895.

Cammerhoff — **Cammerhoff, J: F:** Diary of the journey of Br. Cammerhoff and David Zeisberger to the 5 Nations from May 3-14 to August 6-17, 1750.
Manuscript in the N. Y. state library, translated from the original in Bethlehem Pa. by Miss Clara Frueauff.

Cartier — **Cartier, Jacques.** Short and brief narration of the navigation made by the commandement of the king of France, to the islands of Canada, Hochelaga, Saguenay, and divers others which are now called New France (*in* Hakluyt's prin-

	cipal navigations) Lond. 1600. (*see* Dawson, Sir J: W. Fossil men and their modern representatives. Lond. 1883)
Champlain	**Champlain, Samuel de.** Voyages; tr. fr. the French by C: P. Otis. Bost. 1878. (*see* Prince society. Publications. 2:236)
Cheney	**Cheney, T. A.** Ancient monuments in western New York. (*see* New York state cabinet of natural history. 13th annual report. 1859. *in* Senate documents 1860. no. 89 [e])
Clark	**Clark, J. V. H.** Onondaga; or, Reminiscences of earlier and later times. Syracuse 1849.
Colden	**Colden, Cadwallader.** History of the five Indian nations of Canada. Lond. 1755.
Dawson	**Dawson,** *Sir* **J: W.** Fossil men and their modern representatives. Lond. 1883.
Frey	**Frey, S. L:** Were they mound-builders? (*see* American naturalist, Oct. 1879, 13: 637-44)
Frey. Letters	——— Letters to W. M. Beauchamp.
Hazard	**Hazard, Samuel.** Pennsylvania archives, 1664-1790. ser. 1. Phil. 1852-56.
Hoy	**Hoy, P. R.** How and by whom were the copper implements made? Racine 1886.
Jordan	**Jordan, Francis.** Aboriginal wood working. (*see* Numismatical and antiquarian society of Philadelphia. Proceedings. Phil. 1891. p. 76)
Kellogg	**Kellogg, D. S.** Aboriginal dwelling-sites in the Champlain valley. (*see* American association for the advancement of science. Proceedings. 1887. 36: 308)
Larkin	**Larkin, Frederick.** Ancient man in America. n. p. 1880.
Loskiel	**Loskiel, G: H:** History of the missions of the United brethren among the Indians in North America; tr. fr. the German by C. I. La Trobe. Lond. 1794.
Martin	**Martin, John.** Letters to W. M. Beauchamp.
Moore	**Moore, C. B.** Certain sand mounds of the St John's river, Florida. (*see* Academy of natural sciences of Philadelphia. Journal. Phil. 1894. 10: 5)
Moorehead	**Moorehead, W. K.** Prehistoric implements, a reference book. Saranac Lake. 1900.
O'Callaghan	**O'Callaghan, E. B.** *ed.* Documentary history of the state of New York. Alb. 1849-51.

O'Callaghan. Col. hist. ——— Documents relative to the colonial history of the state of New York. Alb. 1853-87.

Perkins — **Perkins, G: H.** Archaeology of the Champlain valley. (*see* American naturalist, 1879, 13:731)

Radisson — **Radisson, P. E.** Voyages . . . being an account of . . . travels among the North American Indians fr. 1652-1684. Bost. 1885. (*see* Prince society. Publications)

Rau — **Rau, Charles.** Articles on anthropological subjects. Wash. 1882.

Rau. Aborig. ——— Ancient aboriginal trade in North America. Wash. 1882.

Rau. Arch. ——— Archaeological collection of the United States national museum. Wash. 1876.

Relation — **Relations** des Jésuites. Quebec 1858.

More easily accessible in Burrows's fine translated edition Cleveland.

Simms — **Simms, J. R.** Frontiersmen of New York. Alb. 1882.

Smith — **Smith,** *Capt.* **John.** Generall historie of Virginia, etc. Lond. 1624.

Squier — **Squier, E. G.** Antiquities of the state of New York with a supplement on the antiquities of the West. Buffalo 1851.

Stone — **Stone, W: L.** Life of Joseph Brant—Thayendanegea. N. Y. 1838.

Strachey — **Strachey, William.** Historie of travaile into Virginia, Britannia, etc. Lond. 1849. (*see* Hakluyt society publications)

Thomas — **Thomas, Cyrus.** Report on the mound explorations of the bureau of ethnology. Wash. 1894.

Van Curler — **Van Curler, Arent.** Arent Van Curler and his journal of 1634-35; ed. by Gen. J. G. Wilson. Wash. 1896.

Later journal in O'Callaghan, v. 13.
The name is usually spelled Corlear or Corlaer.

Van Epps — **Van Epps, P. M.** The mutilation of archaelogic finds. (*see* American antiquarian, 1894, 16:110)

Van Epps. Letters. ——— Letters to W. M. Beauchamp.

Weiser — **Weiser, Conrad.** Report of journey to Onondaga in 1743. (*see* Pa. archives)

Williams — **Williams, Roger.** Key into the language of America; or, An help to the language of the natives in New England. Lond. 1643.

There are several American reprints, the best being that of the Narragansett club, edited by Trumbull.

Wilson — **Wilson, J. G.** Arent Van Curler and his journal of 1634-35. Wash. 1896.

Published by American historical association.

METALLIC IMPLEMENTS OF THE NEW YORK INDIANS

The stone and bronze ages of Europe have little reference to America except in a very broad sense. Using stone implements here from the earliest times to the present day, men may have used copper also in New York when the whites came, as some others had done centuries before. There had been a time when durable or massive implements were made of this. Customs changed. The later New York aborigines knew little or nothing of these implements, and others employed the material only in an ornamental or reverential way. The earlier nations did not despise this use, and well wrought articles for personal adornment are found in many parts of the United States and Canada. South of our national limits beautiful early articles of silver and gold occur. Recent metallic ornaments are frequent in New York, but none have been reported of native copper except beads.

Most of the early discoverers had something to say of copper ornaments, but these may not have been of native metal in all cases. When the Cabots landed at Newfoundland or Nova Scotia in June 1497, they observed that "the inhabitants had plenty of copper," probably the native metal. When Verrazano visited the coast of New England in 1524, he saw many articles of wrought copper, highly esteemed for their color and beauty. The source of these may be doubtful. Cartier found no copper among the Iroquois of Montreal on his visit there in 1535, but heard of it. "They took the chayne of our capitaines whistle, which was of silver, and the dagger-haft of one our fellow mariners, hanging on his side being of yellow copper guilt, and showed us that such stuffe came from the said river. . . Our capitaine shewed them redde copper, which in their language they call Caquedaze, and looking towarde that countrey, with signes asked him if any came from thence, they shaking their heads answered no; but they shewed us that it came from Saguenay, and that lyeth cleane contrary to the other."—*Dawson*, p. 37

There may have been misunderstandings on both sides, but the plain statement is that this people knew copper and had a name for it, though they had none themselves. When Bartholomew Gosnold was at Cape Cod in 1602 he saw a young Indian with plates of copper hanging from his ears. These may have come from European contact, but Gosnold did not suggest this. Farther south they were visited by natives, one of whom wore a copper plate, a foot long and half as broad, on his breast. Others had copper pendants in their ears. John Brereton added to this, accounts of their beads, chains, arrows and other things, and said that not one lacked something of the kind. Another described pipes partly of copper, much as Hudson did in New York a few years later. Belknap says of these statements:

All these Indians had ornaments of copper. When the adventurers asked them, by signs, whence they obtained this metal, one of them made answer by digging a hole in the ground and pointing to the main; from which circumstance it was understood that the adjacent country contained mines of copper. In the course of almost two centuries no copper has been discovered; though iron, a much more useful metal, wholly unknown to the natives, is found in great plenty. The question, whence did they obtain copper? is yet without an answer.—*Belknap*, p. 151

To this it may be said that the arrows, tubes, belts and pipes of copper, as described by Brereton, are all represented on recent Iroquois sites, and may fairly be considered as European articles, furnished by some unknown early trader.

When it is said that Henry Hudson saw "copper tobacco pipes" among the Indians of New York bay, he may have mistaken those of bright red clay for this metal, or they may have come from the same unknown trader. They were not afterward mentioned by any one, and none of native metal have ever been found. The natives could not have cast them, and it would have been extremely difficult to make them by hammering. The copper ornaments seen in this voyage may have had the same source. The brass pipes which Roger Williams thought the Narragansetts made may well be classed with these. They are never mentioned inland, and this affects the question of origin,

but every article described above was in use by the Iroquois in the 17th century. The arrowheads of 1602 are said to be "much like our broad arrowheads, very workmanly done," and brass arrowheads are spoken of by others.

Native copper articles are rare along the New York seacoast and in our mounds, and perhaps are found more rarely still on camp sites. They seem to have been lost in travel. Apparently implements of native copper have not been made in the interior of New York within 400 or 500 years. This conjecture may be changed at any time, though well founded now. The Iroquois of Montreal knew of this metal in 1535, but had none. The Atlantic coast Indians were then more fortunate, either having European or home sources of supply, or communication with the Lake Superior mines, from which the Iroquois proper were cut off. Both these things are probably true.

For the last we may remember that the larger part of the Huron-Iroquois family were somewhat isolated, the Algonquins surrounding them and for a long time keeping some of them under. No members of the Iroquois family lived west of Lake Huron, but their foes did. So they told Cartier that in the country of metals "there be Agojudas, that is as much to say, an evill people, who goe all armed even to their fingers' ends." These wore the aboriginal armor and were continually at war. The Iroquois were then unwarlike and commanded no access to the mines.

The question of a home supply merits attention. Copper occurs in mines, but so it does in scattered fragments. There are even unprofitable copper ores in New York, but no ledges of this metal. Nodules of several pounds weight have been found in Connecticut and New Jersey, and some may have been used and prized by the aborigines near the coast. Farther north there is little doubt that all articles came from Lake Superior at an early day, and they have such marked peculiarities as to make it probable that they were commonly wrought into shape in that vicinity. Occasional rude pieces found in New York also show this was not always the case.

Soon after Quebec was founded Champlain mentioned a piece of very handsome and pure copper given him by an Algonquin. It was a foot long. The great discoverer said, "He gave me to understand that there were large quantities where he had taken this, which was on the banks of a river, near a great lake. He said that they gathered it in lumps, and having melted it, spread it in sheets, smoothing it with stones."—*Champlain*, 2:236

Presumably this refers to Lake Superior, and the melting merely to softening the metal by heat. The statement lacks precision in these ways, but it would have been possible for an eastern Algonquin while in alliance or friendship with the Hurons to reach Lake Superior.

A succeeding statement is more precise. Radisson wintered in 1658 on the shore of that great lake, and mentioned the native copper several times. He seems to refer to ornamental forms when he speaks of a "yellow waire that they make with copper, made like a starr or a half-moon."—*Radisson*, p. 188, 212. This would bring the making of native copper ornaments far within the historic period, but there is no notice of implements. In the same year occurred the visit which brought Lake Superior copper plainly to view. This was made by an Algonquin chief living on the Saguenay, who had passed 10 years in the country of the Nipisiriniens, and whose name was Awatanik. Thence he went to Lake Superior in 1658, spending the following winter there. Two Frenchmen returned from this lake in 1660 with 300 Algonquins, but they said nothing about copper, though they had wintered there also.

The first definite Jesuit report of Lake Superior ore is in the *Relation* of 1660. In that year a French missionary met the Algonquin mentioned, just returned from that region, where he had gone in 1658. He found there "copper so excellent that it is found fully refined, in pieces as large as the fist." The inference is that the Indians east of Michigan had little knowledge of this before. The *Relation* of 1667 contains the journey of Father Claude Allouez to Lake Superior in 1665. He reached the lake September 2, and went on to say:

The savages respect this lake as a divinity, and sacrifice to it . . . They often find at the bottom of the water, pieces of pure copper, weighing from 10 to 20 pounds. I have seen these many times in the hands of the savages, and as they are superstitious, they regard them as so many divinities, or as presents that the gods who are at the bottom of the water have made them to be the cause of their good fortune; it is for this that they keep these pieces of copper wrapped up among their most precious movables; there are some who have preserved them more than 50 years; others have had them in their families from time immemorial, and cherish them as household gods.

The truth seems to be that the interior aborigines had ceased to use native copper implements more than 300 years ago, some resuming their use at a much later day. Where native copper was known it had become almost sacred, not to be used in common ways. Farther east it was little known, occurring on no village sites in New York, and rarely in camps.

The missionary did not then see the great copper rock projecting from the water, of which he had been told, but later travelers did. He recorded the fact that passers-by cut pieces from this. This is described in the *Relation* of 1670. "Advancing to the end of the lake, and returning a day's journey along the southern side, one sees at the water's edge a rock of copper which weighs at least seven or eight hundred pounds, so hard that steel will scarcely penetrate it. When however it is heated, it is cut like lead."

There are many other mentions of plates and masses of copper seen, but these need not be quoted here. One other quotation will be made to show the sacred character that it had gained, after having had common uses. This is from the same *Relation:*

At that time the savages told a story of a floating island which approached or receded with the wind. Four men reached this one day and prepared their dinner in their usual way. Heating the stones they found and casting them into the water to make it boil, they discovered that they were copper and that this lay plentifully around. After eating they loaded their canoe with pieces and plates of the metal and were soon homeward bound. They had not gone far when a great voice called to them, asking why they carried off the cradles and the diversions of his children. "The plates of copper are the cradles, because among the savages they are made of only one or two boards joined together, on

which they lay down their children; and these little bits of copper which they were carrying away, are the playthings and diversions of savage children, who play together with little stones." One said it was the Thunder spoke; one the god Missibizi; another the water men. Two Indians died on the way home, the others soon after, and no one dared visit the floating island again.

A friend of the writer, the late Dr P. R. Hoy, of Racine Wis. published two papers in 1886 on the important questions, *How and by whom were the copper implements made?* The first paper he read in 1876, the second in 1882. That they were not cast he showed, because the aborigines could not produce the heat required, but copper could be softened by judicious applications of heat and cold. He thought that implements were hammered or pressed into shape in stone molds, and made successful experiments. Lastly, he thought most native copper articles were made after the white men came, a conclusion not so easily proved. His arguments will not be reproduced here, but some of his facts will be mentioned.

Copper articles were made near Lake Superior for export and trade elsewhere. In 1882 there were found 26 copper implements close together, under a small pile of stones at the Sault Ste Marie. In the lot were six awls from 3 to 6 inches long, five knives of various sizes, and 16 axes, hammers and chisels. These must have been made for trade. For recent use he cites witnesses to the copper implements used by the modern Chippewas and Winnebagoes. One Indian agent certified that when he first came among the latter, "many of them carried lances headed with copper, and it was quite common to see arrows headed with copper." These points may have been like those used by the Iroquois 250 years ago. Out of over a hundred mounds opened near Racine none contained copper. Among hundreds of native copper implements in the Perkins collection not one came from a mound. This led him to conclude that such articles were later than the mound builders.

Great quantities of native copper-ornaments have been found in Ohio mounds. Mr Warren K. Moorehead took three or four thousand spool-shaped ornaments out of the Hopewell mounds

alone. These are properly mound articles, thus far unknown in New York. He found there many articles of sheet copper, sometimes stamped or ornamented, naturally suggesting recent material but clearly aboriginal. It is definitely known that native copper was beaten thin enough for turning the edges under and overlaying prepared forms. Out of one of these mounds Mr Moorehead took a copper ax 22 inches long and 6 inches wide. This weighed nearly 38 pounds, not quite seven times as heavy as the largest New York implements of this kind.—*Moorehead*, p. 325

Wisconsin naturally affords the greatest supply, being near the ancient mines. Mr F. S. Perkins sold 143 local copper implements to the Wisconsin historical society, and in 1886 had another collection of over 600 exclusive of beads. The Hamilton collection is also notable, containing most New York forms, as well as small fishhooks and unusual ornaments. The University of Pennsylvania has 560 articles gathered from a space of 5 acres in Wisconsin. The writer met with a curious Wisconsin collection at Manitou Col. The articles were flat and symmetric, cut from rolled or beaten copper and showing none of the irregularities of early implements. Some found at Brewerton N. Y. are suggestive of these. Native copper articles occur in Michigan and Minnesota. In the latter they are well distributed and include eastern forms but are not numerous. Canadian implements are nearly related to those of New York, and the shores of Lake Ontario and the St Lawrence have afforded many. Others occur on both sides of Lake Champlain.

New England is fairly represented and has some notable forms. Pennsylvania has a number of implements and ornaments. Dr C. C. Abbott knew of 128 copper articles in New Jersey in 1885, but they were not all fully wrought. They included 11 celts, five spears, eight arrowheads, 13 bracelets, 70 beads and 21 pieces of copper. At one time he had thought it "not improbable that all the copper articles found along the Atlantic coast were brought from western localities. A careful resurvey of many localities where ordinary Indian stone implements occur in

abundance, and correspondence with collectors in various parts of New Jersey and eastern Pennsylvania now convince me that the use of copper, as implements and ornaments, was much more common than I supposed, and that among the Delaware Indians were many coppersmiths." He cites examples of articles which he thought were made of New Jersey copper, this not being rare. One mass in Somerset county weighed 100 pounds, and it also occurred in the eastern counties of Pennsylvania. Finished ornaments were found in graves with others unfinished, and in one grave was a copper nodule of 13 ounces. His final opinion is thus expressed:

It would appear, then, from an examination of the copper objects found in Pennsylvania and New Jersey, that the weight of probability is strongly in favor of their home manufacture; and the similarity of the forms to those taken from areas where mounds occur is another fact in favor of the rapidly growing impression that the builders of these earthworks and the Indians of the coast were essentially one people.—*Abbott*, p. 774-78

Dr Abbott's statements are weighty, but there are other facts which may prevent their full acceptance. No argument will be held on these now, one important fact clearly appearing, that there were supplies of native copper accessible to the coast Indians which were not available to those in the interior of New York.

Mr David Boyle remarks that copper articles are comparatively rare in the province of Ontario and that the line of distribution seems to be through the Georgian bay and along the Ottawa river. Few have been reported in the Neutral country, lying near the north shore of Lake Erie. As a matter of fact the Toronto collection has many fine examples of early and recent forms. The latter are not so frequent as in New York, owing to the overthrow of the Huron, Neutral and Tobacco nations in the middle of the 17th century. The country was depopulated just as these were beginning to be most freely used. Those of native copper have a few forms not reported in New York. Some fine articles come from Wolfe island, opposite Cape Vincent. As this lies nearer the New York mainland than that of Canada,

these might well be described and illustrated as New York specimens. Those found in the mound at Brockville are merely separated from the New York shore by the St Lawrence, and are like those found elsewhere in the state.

The collection of Mr A. E. Douglass, of New York city, includes 78 copper objects, mainly from Ohio. He does not state how many are of native copper, but divides them into spears, celts, knives, hammers, vessels, beads in lots, bracelets, implements, ornaments, tubes, pipes, arrows and grooved axes. Of these one arrow, one implement, two bracelets and six ornaments are from New York. Nearly half are from Ohio.

Prof. George H. Perkins has described and figured some of the native copper implements of Vermont and Dr Abbott has illustrated a celt from Maine. Some copper articles have been found in Manitoba, but these do not essentially differ from those farther east. Excepting a small space in Ohio distinguished by quite remarkable articles, there is thus a very large district in which nearly all native copper relics are practically of the same types.

It must be remembered that the occurrence of these in the territories of historic nations is no evidence that they were made by them. They are scattered all through the territory of the Iroquois family, but are not found on the village sites of that people, early or late. The presumption is that they were made by an earlier people still. They are found in the land of the Lenape, but we must connect them with known villages of that people before we can assert they were made by them. As far as evidence goes, in the eastern states they were usually lost by the wayside or in temporary camps, or else were buried with the dead. An observation by Dr D. S. Kellogg on those of Lake Champlain is worthy of attention. "Of copper spearheads, hatchets and gouges about two dozen have been found. These have been entirely surface or field finds. Not a single copper relic has as yet (1887) been obtained from a dwelling site." This is not invariable elsewhere, but is a general rule having importance. In New York, at least, all native copper articles may be safely called prehistoric.

As copper was prized for ornamental purposes from the beginning it seems to have been a very acceptable gift from early voyagers. Any metallic ornament would not only be prized but preserved, and there is good reason to suppose that such things, given to the Iroquois of Hochelaga and other places by Cartier or his men, were afterward brought to New York. This will appear in its proper place.

When trade with the Dutch and French opened more fully in the early part of the 17th century, metallic implements and ornaments were in great request. One has only to look over old bills of supplies and purchases to see how great was their quantity and variety. For ornamental purposes bronze, brass and nearly pure copper long had sway. About the beginning of the 18th century silver began to take its place, and for 150 years held its own as the fashionable material. Loskiel spoke of this. "The rich adorn their heads with a number of silver trinkets of considerable weight. This mode of finery is not so common among the Delawares as the Iroquois, who, by studying dress and ornament more than any other Indian nation, are allowed to dictate the fashion to the rest."—*Loskiel*, p. 52

A great number of forms became common, and all were lavishly used. Some were very beautiful and were tastefully employed. At first they were made by the whites, but the Iroquois soon learned the art and had their own smiths in every village. Such ornaments were abundant till the civil war, when the high price of silver brought many to the smelting pot. It is difficult to obtain even the smaller ornaments now.

Prof. Cyrus Thomas has wisely called attention to the large supply of copper furnished to the coast Indians by early explorers and colonists, and to the use made of it. He says:

A careful examination of the copper articles found in the mounds should lead any one, not swayed by some preconceived notion, to the conclusion that many of them were made of copper brought over to America by Europeans, which would as a matter of course indicate (if they do not pertain to intrusive burials) that the mounds in which such specimens are found were erected subsequent to the discovery by Columbus. The

copper articles found in the mounds and ancient graves belong, as may be readily seen by those who will inspect them, to two usually very distinct classes; those of the one class evidently hammered out with rude stone implements; those of the other class showing as plainly that they have been made from quite thin, smooth, and even sheets.—*Thomas*, p. 710

He has no doubt that some important mounds were made in quite recent times, and cites many early authorities to show how great a supply of metals was afforded to the Indians by European explorers, traders and colonists. In Virginia they were lavish with copper, and Smith said that in a short time goods "could not be had for a pound of copper which before was sold us for an ounce."—*Smith*, 1: 166. Strachey said that Powhatan wished to monopolize the copper trade:

Whereas the English are now content to receive in exchange a few measures of corn for a great deal of that mettell (våluing yt according to the extreme price yt bears with them, not to the estymacion yt hath with us), Powhatan doth again vend some small quantity thereof to his neighbor nations for one hundred tyme the value, reserving, notwithstanding, for himself a plentiful quantity to leavy men withal when he shall find cause to use them against us, for the before-remembered weroance of Paspageh did once wage fourteen or fifteen weroances to assist him in the attempt upon the fort of Jamestowne, for one copper plate promised to each weroance.—*Strachey*, p. 103

It appears that Powhatan had articles or pieces of native copper, but they were not abundant nor as beautiful as those of the English, and so he coveted these. Capt. John Smith often referred to this trade in copper and iron, but his most important statement was in connection with his visit to the Tockwoghes in 1608. These lived far up Chesapeake bay, and were at war with the Massawomeks, a branch of the Iroquois family, and probably a part of the Eries. The Susquehannas were friends of the Tockwoghes, and of the latter he said: "We saw among these people many knives, hatchets, and pieces of brass, which they said they had from the Sasquesahanocks, a mighty people, and mortal enemies to the Massawomeks." He elsewhere describes his visit with the Susquehannas, adding that, "many descriptions and discourses they made us of Atquanahucke,

Massawomekes, and other people, signifying they inhabit the river of Cannida, and from the French to have their hatchets and such like tools by trade."

The Virginia Indians told him that this hostile people lived "on a great salt water, which by all likelihood is some part of Commada, some great lake, or some inlet, or some sea that falleth into the South Sea." In his well known account of his battle on Lake Champlain in 1609, the great French explorer observed that the Mohawks had axes of iron, though that year included his own first visit to New York and the first Dutch voyage up the Hudson river. He said: "The Iroquois repaired on shore, and arranged all their canoes, the one beside the other, and began to hew down trees with villainous axes, which they sometimes got in war, and others of stone, and fortified themselves very securely." We are thus not to limit the possible use of European metallic articles in New York to the year 1609. It is every way probable that a few implements or ornaments reached the interior many years before, and in some instances these may have been found.

Attention has elsewhere been called to early wrecks along the Atlantic coast, whence some metal was obtained. More of these occurred than ever were reported. Fishermen from Europe haunted the mouth of the St Lawrence and the points and islands adjacent but did not publish their voyages. They were not exploring, but getting a living. In a similar way, at a later day, there were French and Dutch traders penetrating the wilds of New York, of whose names and adventures we are equally ignorant. For their own profit they said as little as possible.

It is somewhat surprising to see how rapidly our knowledge of the early use of copper has grown. Squier and Davis brought to light many copper ornaments and articles in their mound explorations, the report of which was published in 1848. The report of Foster and Whitney on the Lake Superior district, published in 1850, showed something of the early work done there. Schoolcraft was at his best in that region. Lapham

added much in writing on the antiquities of Wisconsin in 1855. Col. Whittlesey published his account of ancient mining on Lake Superior in 1863, yet Dr Charles Rau said, in his paper entitled *Ancient aboriginal trade in North America:* "The Smithsonian institution has been receiving for years Indian antiquities from all parts of North America, yet possessed in 1870 only seven copper objects: namely, three spearheads, two small rods, a semilunar knife with convex cutting edge, and an ax of good shape."—*Rau. Aborig.* p. 94. There are more there now, and yet but few compared with some private collections.

The Lake Superior copper sometimes contains small masses of native silver. Where this is present the source of the supply may be known but its absence is no test. Most articles show raised spots and lines, retaining a hammered appearance. The softer metal between is corroded. The stone hammers and rude wooden tools of the early miners are yet found where they worked centuries ago. Col. Whittlesey thought 500 years had passed since that time; Mr Lapham allowed a much more recent period. It will be seen that the Jesuit *Relations* speak of work done there in the latter half of the 17th century. While it is probable that many implements were made in adjacent districts, it is perfectly clear that masses of metal were carried away to be cut up and wrought elsewhere. Such blocks have been found and the Jesuits mention those that they had seen or owned.

In common with others the writer at first could hardly resist the belief that the early copper articles brought to him were cast in a rude matrix of sand. Much of the surface appears like a rough casting, and the longitudinal raised lines could be attributed to cracks in the mold. Dr Hoy thought the metal was subjected to a great pressure in a matrix of stone. The prevalent opinion now is that all our implements of this kind were hammered into shape. One surface is usually flat but the reverse quite commonly has a central and longitudinal ridge. On this surface the workman hammered along one side and then changed ends to hammer the other, the slightly oblique

blows producing a central ridge. Dr Thomas Wilson, of the Smithsonian institution, told the writer of his experiments in such forging, and gave a high rank to the aboriginal workman. He found peculiar difficulties in bending over the lower edges to form the socket. This feature appears in some European bronzes locally termed winged celts. Some New York articles show greater skill than any copper celts in Washington.

The Indians, however, soon learned to cast metals, if reports are true. Roger Williams said of those in New England: "They have an excellent Art to cast our Pewter and Brasse into very neate and artificiall Pipes." Such pipes were found in New York, but melting brass has difficulties, and such a native art may be doubted. Metal was sometimes used for lining pipes, both of horn and stone, and there are other examples where stone and metals were otherwise combined. All these are recent.

The distribution of early copper articles in New York is somewhat uniform on the whole, excluding the lower Hudson and Long Island. Cattaraugus and Chautauqua counties have some reputation in this way but the rather indefinite reports seem exaggerated. A good antiquarian says that in 50 years residence he has seen but one native copper arrowhead there. Onondaga county and the drainage of the Genesee river have afforded many. Fine examples have come from Jefferson county and the islands of the St Lawrence. Lake Champlain and the upper waters of the Hudson are well represented by these early relics. Some have been found on the Susquehanna.

It seems certain that the Iroquois had no metallic articles which they did not have from the whites. These they gladly adopted and the advent of the Dutch became a new era in their life. All Europeans were termed by them *Ascronni*, Makers of axes, but this was specifically the name of the Dutch. This was the definition of Father Bruyas, an excellent authority. Megapolensis interpreted it differently: "They call us *Assyrconi*, that is Cloth-Makers, or *Charistooni*, that is Iron-Workers, because our People first brought Cloth and Iron among them."—

Hazard, p. 517. It seems better to make the word mean Knifemakers than to refer it to axes. Axe is *atoko*. In the old Mohawk *assire* was cloth, and *assere* knives, so that either definition would stand as given by Megapolensis.

Loskiel said, "Many of the Delawares and Iroquois have learned to make very good rifle-barrels of common fowling-pieces, and keep them likewise in good repair." They also learned to make silver ornaments from coin, and even to insert colored glass when desired.

Native copper articles

It will be seen that articles of native copper stand distinctly apart from all others, and should be considered by themselves. With slight exceptions those of New York have a useful character, and were probably all made before the close of the 15th century. Some found on early Huron sites in Canada may have had a more recent date and some may well have been known to the later Hurons, reaching them through western trade. The form suggesting our case knife has been thought to show a knowledge of European art, but specimens of this are rare both in Canada and New York. The copper hooks of Wisconsin imply the same, but no early examples of these have appeared here.

One fact must be borne in mind in speaking of the scarcity of any early metallic articles. In early pioneer days in New York recent Iroquois village sites were prized sources of supply for iron and brass. Reference to this will be made later. Native copper articles have proved useful or salable, and many a one has gone into the crucible. Some of the finest figured by the writer have been barely rescued from such a fate, and others lay for years in the farmer's tool chest, serving some rude end. The present scarcity is therefore no absolute test of former numbers, though they were probably small. This is partly inferred from the opening of new sites, where other articles abound. Those found seem to have belonged to transient visitors and not to a settled people.

A large proportion of these remarkable articles have the celt or chisel form, usually narrower at one end than the other, but sometimes with the edges parallel. The finest brought to the writer's attention was once owned by the late J. S. Twining, who sold it to some one outside the state. Fig. 61 is reduced one half in length from the outline furnished by Mr Twining, the full length being 14¾ inches and the breadth 1⅞ inches. The greatest thickness of the lateral edge is ⅝ of an inch, the total thickness being about double this. It weighs 5½ pounds. One surface is flat, and the other ridged as usual. The ends are thinner than the center but one is beveled to a sharp cutting edge. It was plowed up by Mr Farnham at Oxford N. Y. in 1856, and Mr Twining bought it of his heirs. It is to be regretted that this unusually fine article did not remain here.

Fig. 7 is a reduced drawing of another copper celt, almost the counterpart of the preceding except in size. Its weight is 2 pounds, 14 ounces, or a little more than half that of the last, but it is but about a fifth shorter. This implement is slightly beveled in thickness toward each end, one of these having a dull chisel edge. It is 11½ inches long, $1\frac{9}{16}$ broad and $\frac{13}{16}$ thick, being a little wider at the cutting edge where it suddenly and slightly expands. One surface is nearly flat but a little depressed along the center; the other ridged as usual but slightly hollowed on each side of the central line of the ridge. This is a common feature. There are the usual flattened rough lines, showing traces of the hammer. The first owner cut the upper corner to test the material, a very frequent practice. This fine celt was found in May 1880 by Mr J. F. Shultz on lot 22, town of Clay N. Y. and was at first sold for old copper, but soon came into the Bigelow collection, where it may now be seen.

Fig. 3 is of the same general form and is much reduced. It is ridged on one side but is narrower at one end than at the other. This is in the Smithsonian institution where it is credited to Keeseville N. Y. Dr D. S. Kellogg locates it more exactly at Auger pond, Keeseville, where it was found many years ago by a Mr Hackstaff. It is 9⅞ inches long and has a medial width of 1½ inches, being somewhat smaller than the last.

Fig. 5 is also reduced, and the lateral edges gradually contract. It is $7\frac{1}{8}$ inches long with a medial width of $1\frac{3}{8}$ inches. The cutting edge extends to a central point and the bevel to the ridge commences almost at the flat surface, which is the one shown. The first owner unfortunately filed down most of the rough ridges on one side of the back. It was found on the farm of B. C. Case, north of Lake Neatawantha and toward Oswego river, near Oswego Falls. It is now in the Bigelow collection. The bevel at the point is more abrupt than usual.

Fig. 9 is another fine celt in the same collection, which embraces a large proportion of the native copper articles illustrated here. It was found by Mr Charles Woods on his farm, about 3 miles due east of Baldwinsville N. Y. lot 82, Lysander. This was in April 1878. The hard ridges are black, appearing mostly on the flat side, where a narrow central one extends from end to end. The under surface is ridged as usual and it is somewhat pointed at both ends, the cutting edge being almost rectangular in the center. The extreme length is nearly 7 inches, the greatest width $1\frac{1}{2}$ inches and the thickness $\frac{1}{2}$ inch. Below the center the sides are nearly parallel as far as the cutting edge and most of the small ridges are toward that end.

Fig. 10 was in the collection of Mr Albert Hopkins of Phoenix, but its present abode is unknown. It was found in Oswego county in 1878 and has undergone some filing, without seriously affecting its character. On the flat surface represented the hard, longitudinal ridges are unchanged. The expanded and rounded edge on this side is slightly hollowed like a shallow gouge. The back is rounded, not distinctly ridged. The extreme length is $5\frac{3}{4}$ inches, medial width 1 inch, width of edge $1\frac{5}{16}$ inches and thickness $\frac{3}{8}$ inch.

Fig. 53 is a parallel edged copper celt in the collection of Mr John Martin, Plattsburg N. Y. It was found on the Jones farm 2 miles north of that place. The surface is beveled toward each end, moderately sharpened at one, and is weathered and green. It weighs $7\frac{1}{2}$ ounces. The owner says: "One end was pounded by a hammer, which shows that one end was lapped."

Fig. 39 has also parallel edges and is quite broad for its length. It is in A. H. Waterbury's collection, and was found between Bridgeport and Oneida lake. The length is $4\frac{5}{8}$ inches and the average width $1\frac{3}{8}$ inches. The edge is rounded and slightly expanded.

Fig. 40 is still wider in proportion and suggests an ax. It belongs to Mr Albert Rose of Manchester Center, Ontario co. N. Y. and was found on the Rose farm, a little over a mile north of the old ford at Canandaigua outlet. Mr Irving W. Coats made the drawing in 1892. He says it is of native copper and is 3 inches long. The extreme breadth is $1\frac{5}{8}$ inches, being a little less at the head where there is a rounded depression. The cutting edge is curved, as usual.

Fig. 23 has the modern ax form and came from Livingston county, N. Y. It is of native copper but has unfortunately been ground down. This is in the Smithsonian collection and is of actual size.

Fig. 60 is taken from Squier's *Antiquities of the state of New York* (p. 122) and is here of actual size. He said:

One of the most interesting relics which has yet been discovered in the state, is an ax of *cast copper*, of which fig. 25 is a reduced engraving. The original is 4 inches long by $2\frac{1}{2}$ broad on the edge, and corresponds in shape with some of those of wrought native copper, which have been found in the mounds of Ohio. From the granulations of the surface it appears to have been cast in sand. There is no evidence of its having been used for any purpose. Its history, beyond that it was plowed up somewhere in the vicinity of Auburn, Cayuga county, is unknown. No opportunity has yet been afforded of analyzing any portion, so as to determine whether it has an intermixture of other metals. It appears to be pure copper. An inspection serves to satisfy the inquirer that it is of aboriginal origin; but the questions when and by whom made, are beyond our ability to answer. There is no evidence that the mound builders understood the smelting of metals; on the contrary, there is every reason to believe that they obtained their entire supply in a native state, and worked it cold. The Portuguese chronicler of Soto's expedition into Florida, mentions copper hatchets, and rather vaguely refers to a "smelting of copper," in a country which he did not visit, far to the northward, called "Chisca." The Mexicans and Peruvians made

hatchets of copper alloyed with tin. It would seem that this hatchet was obtained from that direction, or made by some Indian artisan after intercourse with the whites had instructed him in the art of working metals. At present it is prudent to say that the discovery of this relic is an anomalous fact, which investigators should only bear in mind, without venturing to make it the basis of deductions or inferences of any kind.

Mr Squier was one of the most accurate and judicious of writers and these words may have held in check the extravagant surmises and theories in which some of his contemporaries indulged. At the same time some of our best authorities have determined that many articles which appear to have been cast were really brought into shape by hammering. The first impressions are of a rude casting.

Dr Charles Rau at first allowed the casting of this article.—*Rau*, p. 92. In collecting his papers in 1882 he made a prefatory note as follows:

Reference is made to a *cast* copper ax plowed up near Auburn, Cayuga co. N. Y. and first described and figured by Mr Squier on p. 78 of his *Aboriginal monuments of the state of New York* (Wash. 1849). Several years ago, while in conversation with Mr Squier at his residence in New York I happened to see the same ax lying on the mantelpiece. In handling the object I noticed that a small portion had been removed from it—for close examination by an expert, as Mr Squier informed me. This examination resulted in the discovery that the ax was not cast but hammered into shape from native copper. The former inhabitants of North America, I still believe—notwithstanding all assertions to the contrary—were unacquainted with the art of melting copper.—*Rau*, pref. p. vii

As to modes of working copper and the differences between the native metal and that brought by Europeans, reference may be made to a valuable paper by Mr Clarence B. Moore. He gives analyses of several articles from recent New York sites, but was unable to obtain those of native copper. From other sources some were procured. In that paper he quotes a personal letter from Prof. F. W. Putnam which is of general interest and is therefore reproduced here:

Just after I wrote my little paper on copper in the museum as the beginning of a series of papers on the use of metals,

copper began to come in from our Ohio explorations in a wonderful manner, until we now have copper in such abundance that a paper on the subject would be a volume. We have it hammered and cut into all manner of shapes—implements and ornaments—and with it have come several lots of ornaments made of meteoric iron—implements and ornaments—and also considerable silver (ornaments) and a little of gold. All these metals are hammered and cut, and we have the copper in all stages from the rough nuggets, through those partly hammered, to the sheets and the objects cut from them. To consider this the work of Europeans is an absurd perversion of the facts before us; and yet just because the facts do not agree with the theories of some who would have all facts drop into their theories, or else throw them out of consideration, these objects are spoken of as unquestionably of European origin, *traded* to our old mound building people of the Ohio valley by whites since the settlement of the country.—*Moore*, p. 220

Prof. Putnam's conclusion is that native copper articles of any kind are to be considered prehistoric if unaccompanied by European relics. Dr Cyrus Thomas has as plainly shown that European metallic articles have been found deep in some large mounds. His remarks have been quoted.

A large proportion of native copper celts gradually expand toward the cutting edge. Fig. 38 is a good example in the Bigelow collection, which was found on lot 99, Lysander, in 1881, not far from Seneca river. The ridged side has more protuberances than usual, and on the flat side a single medial line extends the whole length, with a few small ones near the margin. The thin top is bent over by hammering, showing how it was used. This figure is of actual size, as are all those where no dimensions are given.

Fig. 30 is in the same collection, and has an expanded cutting edge. It was found on the Ouderkirk farm, lot 76, Lysander, near Seneca river, and is quite thick and not very sharp, the edge having been dulled by use. One side is ridged as usual.

Fig. 12 is a very fine celt of this kind, the flat side of which is shown. A hollow above the cutting edge suggests a gouge. This edge is more rounded than usual and the other end comes to a point. The full length is a little over 5½ inches, and the

implement is quite sharp. It was found on the Voorhees farm, lot 99, Lysander, in 1881. A lateral view is added.

Fig. 19 is a fine copper celt from Point Alexander, Wolfe island, north of Cape Vincent N. Y. It is much more tapering than most of those described and is 7 inches long. Though just north of our border it was found by one of our citizens and is in the Richmond collection. All along the St Lawrence the occurrence of copper implements on either shore may be considered an accident of travel. They occur on Wolfe island, Tidd's island near Gananoque, at Brockville, and on islands farther down the stream.

Fig. 62 was found on the south side of the Oneida river at Brewerton, and is in the Bigelow collection. It is $5\frac{3}{8}$ inches long, and is nearly flat on both sides. There are many linear ridges and it is somewhat sharp at both ends. The broad end had the corner cut by the finder.

Fig. 28 is from Dr Rau's half length of a New York copper celt, fig. 227 of the *Archaeological collection of the United States national museum.* He said of this:

The most beautiful article of a wedgelike character is a kind of chisel with an expanding, strongly curved edge, which shows a slight concavity, imparting to the implement almost the character of a gouge. The upper surface is nearly even, but the back part presents, as it were, two faces, which join in the middle, forming a longitudinal ridge.

Fig. 4 is from an outline sent to the writer by Dr D. S. Kellogg of Plattsburg N. Y. and shows a rude copper knife or hatchet, having the usual raised lines on both sides. It is reduced in the figure, measuring 3 inches between the extreme points.

Fig. 73 shows a large copper gouge with parallel edges. Perhaps from some flaw in the metal it was partially broken at the upper end and an attempt has been made to cut it off. It was found near Constantia, on the north shore of Oneida lake, about 1850, by Mr James Haynes. It went into the Terry collection. No implement has been found like it here and it is quite deep and thick.

Fig. 1 seems the finest specimen of its class yet found, weighing 3 pounds, 2 ounces, and being a little over $10\frac{1}{4}$ inches long.

The extreme width is 2 inches and it is 1½ inches wide at the narrow end. The extreme depth is 1½ inches. It is ridged on the lower side and high and sloping flanges form a socket at the broad end. These occupy more than a third of each lateral edge and a broad depression extends between them for 3½ inches, against the angle of which the handle abutted. This feature often appears in spearheads made for similar hafts. It was found by Chester Wells in 1885, a mile south of Granby Center and was long used as a wagon wrench. A small piece was broken out of one of the flanges by him. The point is also now dull, but this might have been so centuries ago. It is now in the Bigelow collection. There is a smaller one like this in the national museum, which Dr C. C. Abbott called "a nameless object." It is 7⅜ inches long and has an extreme breadth of 1½ inches. The flanges occupy full half of the length and the socket measures 3¼ inches to the abutting angle. This came from Somerville N. J. A copper gouge, found in the Brockville mound, Canada, has similar features. In the Toronto collection there is a large adz of the same type but on the whole it is a rare form.

Fig. 21 is a very small article of native copper like a celt, and neatly formed. It is quite flat and was found on the island at Brewerton.

Fig. 22 came from the same place. It is a small cylindric piece of native copper which appears to have been worked, but not into any definite form.

Fig. 75 is a long and somewhat triangular article of native copper, which is flat and of uniform thickness throughout. It may be unfinished but would serve as a rude spear without sharpening. This was found at Union Springs and weighs 1½ ounces. It is 5¾ inches long and the expanded base is nearly an inch wide. This may have been the beginning of a flanged socket.

Fig. 29 is a tube of native copper which may have been ornamental or useful, either as bead or sinker. A section of this is shown. It is rough, and made of a copper plate bent into a

cylinder and hammered together. One end is thin. It was found on the Oneida river about 20 years ago but its present owner is not known. The length is $2\frac{1}{2}$ inches.

Fig. 17 is a sharp and slender awl from Mr S. L. Frey's article in the *American naturalist* of October 1879, entitled "Were they mound-builders?" He said:

It might have been used for piercing holes in buckskin garments but as implements for this purpose were usually made of bone, with the point rounded and sharpened in a similar manner, and as these were obtained with comparative ease and were equally serviceable for sewing purposes, I think that possibly this copper implement had a different, or at any rate an additional use. According to many early writers the natives at the time of the discovery were found in possession of ornaments, necklaces, etc. of pearls, the perforating of which was done with a heated copper spindle. The square shape of this implement indicates that it has been set in a handle, and the point being very smooth, shows use of some kind. That it was intended for a drill of this description seems not improbable when viewed in connection with certain shell relics subsequently found, and which are described in this article.

The great neatness of this implement led to further inquiry and Mr Frey wrote: "The copper awl you figure from my drawing is exact. It is just as smooth and well finished as represented. It is the only prehistoric copper I ever found; in fact the only one, as far as I know, ever found in this section." This illustrates the curious elimination of early travel and habitation in the Mohawk valley. East, north and west of that valley, native copper articles have been often found.

The burial place was of a mixed character, for at the time he found this Mr Frey had not discovered the curious graves and relics which rewarded his labors at a later day. In his earlier digging he had found "at one time, in a grave, 30 arrowheads and a small copper awl." In one of those opened afterward he found copper beads, to be mentioned later. This judicious observer noted the widely different character of the graves, concluding that they could not be those of the same people. It is also to be remembered that there was no large village site close at hand, and that part of the cemetery had been removed before examination. The writer has since examined this awl.

Regarding Mr Frey's general question a few words should be said. But one other awl of this character has been reported from this state and this is much larger. It was a surface find. In other states they have been found in mounds. Prof. Cyrus Thomas reported several of these with illustrations and they closely resemble those of New York. In the Sue Coulee group, Crawford county, Wis. were copper articles with one of the skeletons. "Near the hand of the same skeleton were two long, slender, square copper drills or spindles, one about 9 inches long and ¼ inch thick, pointed at one end and chisel-shaped at the other; the other 7 inches long and pointed at both ends."—*Thomas*, p. 76. In another mound of the same group was a small one of similar character and a large copper ax, with copper beads and an obsidian implement. In one of the Rice lake mounds, Wisconsin, was a similar drill or spindle 7½ inches long and pointed at both ends. In a mound on the Holston river, Sullivan co. Tenn. a copper spindle lay on the head of a skeleton. "It is 11 inches long, ¼ inch in diameter at the thickest part and appears to have been roughly hammered out of native copper with some rude implement. Immediately under the lower jaw were two small copper drills or awls with portions of the deer-horn handles still attached."—*Thomas*, p. 351. These quotations will show the proper place of the New York copper awls.

Native copper spears of two types have a wide range. In some the base is drawn out into a sharp or obtuse point for insertion in the shaft. These are usually notched on the lower edges for attachment by cords. In others the lower edges are raised and bent over, forming an angular socket, neatly made. This is often deepened for a short distance so that the shaft abuts against a shoulder. The flanges usually turn inward, giving a firmer hold. Unless very thin the blade is flat on one side and ridged on the other, and the usual hammered protuberances appear. New York specimens may have one or two notches on each side but some have none. In other states they occur with several deep and narrow notches on either side. Prof. G. H. Perkins has figured a fine example of this kind from Ver-

mont, and Mr Francis Jordan jr of Philadelphia found one remarkable example in 1890 on the eastern shore of Maryland, which is about 12 inches long, ridged and angular, and with six notches on each side of the base. This form has not been reported here. He found a large hoe blade of copper at the same time. The former is figured in the *Proceedings of the Numismatic and antiquarian society of Philadelphia for 1890–91*, p. 128.

Fig. 74 is a curious undulating spearhead obtained by Mr Twining in Ellisburg N. Y. There are double notches on each side of the base and the undulating edges are suggestive of some Scandinavian weapons. It is quite slender for its length, being 7½ inches long with a maximum width of ⅝ inch near the base, which terminates in a sharp point. Those found near the Seneca river often end in this way.

Fig. 35 is a very fine example from the latter region, now in the Bigelow collection. It is one of those drawn by the writer for Dr Abbott's *Primitive industry*, and was found on the Crego farm, just west of Baldwinsville and south of the river, near but not on an early fort site. The writer afterward found a small native copper bead there. The flat side is slightly concave, giving the implement a decidedly curved appearance. The present length is 7¼ inches, but the basal point has been slightly broken. The extreme width is a little over 1½ inches. There is a basal notch on each edge for attachment. Each side of the longitudinal ridge is moderately hollowed, and the usual raised lines appear, the whole implement suggesting a rough casting, an appearance now known to be deceptive.

Fig. 31 is also in the Bigelow cabinet and was found on the Judge Voorhees farm, lot 74, Lysander, in 1875. It has a pointed base, but no notches, and is but slightly ridged. The blade is much thinner than the general base, a common feature with this form. A smaller similar one was found near Beaver lake, about 2 miles northeast of the last locality. This has disappeared.

Fig. 27 is in the same collection and much like the last. It was found in uprooting a large tree in the town of Hannibal in 1878–79.

Fig. 26 is a rough native copper spear with an obtuse point, possibly broken or unfinished. It is in the Smithsonian collection and came from Malta N. Y., west of Saratoga lake.

Fig. 25 is in the same collection, and came from Livingston county, N. Y. The base is not pointed and the implement suggests both the knife and spear. It is slightly rounded, and there are no basal notches.

Fig. 32 is in the Bigelow collection, and was found on R. Adsit's farm, lot 76, Lysander, north side of the river road and toward Beaver lake. Several copper implements have been found near there. This is a small form, flat on on side and rounded on the other. There is a notch on each side toward the pointed base. It is hardly 3¾ inches long but is neatly finished.

Fig. 50 is a thin copper spearhead found half a mile east of Onondaga creek, and nearly a mile south of East Onondaga village, beside an old Indian trail. It is ridged on one side and has a deep notch on each edge near the base. The base is obtusely pointed. It is but 3⅛ inches long, and the edges are nearly parallel and quite sharp. It was found in 1894 by Mr George Slocum, its present owner, and is slightly twisted as a whole.

Fig. 49 has the outline of a pointed ellipse, rather obtuse at the base. One edge has one notch and the other two for attachment. It would have answered well for a knife and is as long as the last. It was found in the town of Venice, Cayuga co. in 1886.

Fig. 44 is another of these small spears, much thicker than the last two. It has a pointed base and opposite notches which are nearly midway in the edges. This was found on the north shore of Oneida lake June 12, 1886, on a point east of Big bay. The writer visited the spot afterward and found arrowheads and drills. The finder was Mr White of Geddes, then superintendent of schools, who soon disposed of it. It is not so distinctly ridged as some, but has the usual protuberances. The length is 3 inches.

Fig. 42 is from a drawing of a small spearhead in the state museum made by Mr R. A. Grider. It was obtained from the

collection of A. W. Allen, made on the east side of Cayuga lake. It is ridged, has a single notch in one edge and two in the other, one of the latter being midway. As drawn it is $2\frac{7}{8}$ inches long.

Fig. 55 is another of these short and broad forms. Below the notch on each side the edge projects into a kind of barb. The base is pointed and one surface ridged as usual. It is quite broad for its size, the length being $2\frac{3}{4}$ inches and the width 1 inch. It is in Dr D. S. Kellogg's collection and was found in the town of Peru, Clinton co. N. Y. Many articles of native copper have been found along the west line of Lake Champlain.

Fig. 41 is a longer spearhead with single notches on each edge, and a pointed base. It is slightly ridged on both surfaces, and is well finished. The length is slightly over $4\frac{1}{2}$ inches. This is in the Bigelow collection and was found near the Seneca river in Onondaga county.

There are many of the same general character which have an obtuse base. Fig. 11 differs from most of these, the base suggesting some yet to be described. The outline of this broken implement is much like that of some triangular notched flint arrows, and the surface is flat but has the usual lines on one side. It belongs to the writer and was found near Jack Reef, Seneca river.

Fig. 36 is a shouldered spearhead, without notches and with an obtuse base, which is in the Kellogg collection and came from Chazy. The base is a broad shank, slightly expanding near the end.

Fig. 14 may be either knife or spear, and is in the same collection. It was found at Plattsburg and, like the last, has no notches.

Fig. 65 is also in the Kellogg collection, and is quite large for this form, being $6\frac{1}{4}$ inches long. The other general features are much like those just described. This is from Plattsburg.

Fig. 68 is another slender implement in the same collection which was found on Valcour island in Lake Champlain. There are no notches and but slight shoulders. It is quite slender for the length, which is $5\frac{3}{16}$ inches.

Fig. 57 is in the same cabinet and was found at Schuyler Falls. It has a long broad shank, is distinctly shouldered, and quite irregular in outline.

Fig. 59 was found at Plattsburg and is in the Kellogg collection. It is distinctly ridged and has a notch on each edge near the base. The latter is obtusely pointed.

Fig. 16 closely resembles the last but is much larger. It was drawn by Mr Grider from a fine spearhead belonging to Mr W. B. Murphy of Schoharie county.

Fig. 34 is a fine spearhead found on the Randall farm near Saratoga lake and now in the state museum. The base is slender and pointed and the whole implement is narrow for its length, which is $7\frac{3}{8}$ inches.

Fig. 52 is in the collection of John Martin, Plattsburg, who says: "It was found when the new road was constructed past the United States army post at Plattsburg some 15 years ago. The place was on the right bank of the Saranac river some $\frac{1}{2}$ mile from the mouth." It is slightly ridged but is thin for its length, which is $6\frac{3}{16}$ inches. The shank is obtuse and it is moderately shouldered. Corrosion has turned it green. Mr Martin furnished fine photographs of his copper articles.

Three flat spearheads in the Waterbury collection and found together on the north side of the river at Brewerton, are of unusual character, and may be comparatively recent. No analysis of the metal has been made. They are quite flat, and are deeply notched at their broad bases, even more than one already mentioned. Fig. 71 shows one of these. There are a few striae, and the edges are sharp and beveled. The general appearance suggests a recent origin, with some peculiar features, but no age has been claimed for or assigned to them. Fig. 43 and 45 are the other two.

Fig. 20 is thus far unique in New York, though found sparingly elsewhere. It is a thick gouge, $2\frac{3}{4}$ inches long by $2\frac{3}{16}$ broad, having the sides turned into contracting flanges. The back is curved and the cutting edge abruptly beveled. It was found on the left side of the road from Port Byron to Howland island

near the Seneca river bridge. Some call this form a spud and it has been previously reported only from Wisconsin and Minnesota. It now belongs to Mr Harris of Rome N. Y.

Fig. 24 has an outline much like that of our modern knives. It is rare in New York but seems more common in Canada and elsewhere. It was found in Cayuga county and has a few of the usual raised lines. This is a good example of this form.

Fig. 78 is a much larger one in Mr W. L. Hildburgh's collection, found in Livingston county. His note is that "a meadow lark's wing was found bound on this." What evidence there is of this is not stated. Such knives have been found originally wrapped in fur, retaining traces and sometimes portions of this, for the salts of copper often preserved perishable articles.

There are many New York examples of native copper articles having a socket for the handle, made by turning up the edge. A fine example is in the Smithsonian collection, which was found in Tompkins county, N. Y. Fig. 2 shows this much reduced, the actual length being 9 inches. The socket is less artistically wrought than some and the back of the blade is rounded. It is quite thin for its size.

Fig. 13 is a very fine spearhead of this type, found near Seneca river, lot 75, Lysander, in 1893. It is in the Bigelow collection and is 6⅛ inches long. The back is ridged and the socket moderately expanded toward the base. The flanges are neatly turned inward and there is the frequent angle between the socket and blade against which the shaft abutted. The inside surface of the socket is perfectly smooth, as though the shaft had decayed within it. A lateral view of this is given and no better example has been found here.

Fig. 33 is another found on Wolfe island, opposite Cape Vincent N. Y., now in the collection of Dr A. A. Getman of Chaumont N. Y. The finder bored a hole in the base for suspension, but the writer omitted this misleading feature. The socket expands toward the base as usual and occupies nearly half the length of the implement. It is also depressed but has not so abrupt a shoulder as the last.

Fig. 37 is a very thin copper knife or spear of this type, found near Cold Spring on the Hudson and belonging to Mr James Nelson of that place. It is $2\frac{3}{8}$ inches long and $\frac{3}{4}$ inch wide with a perforation near the base. Not being symmetric it may have been a knife. If of native copper the hole would be an anomaly, but the figure suggests a recent article and Mr Nelson's note called it sheet metal.

Fig. 56 is of the same class, the flanges contracting more than usual in the outline sent by the owner, Mr W. T. Fenton of Conewango Valley N. Y. In a note on this article Mr Fenton said: "I have lived in this valley over 50 years but have seen but one copper arrowhead. Of that I send you outline of actual size. It was found in the town of Poland, Chautauqua co. Mr Larkin claims to have found some copper ornaments in a mound he opened a great many years ago, but if I remember right he sent them to the Smithsonian institution."

In his *Ancient man in America* Dr Larkin often speaks of native copper articles, without mentioning their final resting place. In a letter to the writer he says he thought he sent them to the Smithsonian institution or the Peabody museum. Nothing could be learned of them there and it is to be regretted that all have disappeared. His published statements may be quoted without comment, omitting minor matters:

In the year 1859 while exploring some tumuli in the vicinity of the Red House valley we found numerous singular and interesting relics, among which were spearheads 6 inches in length with double barbs composed of masses of native copper; also several blocks of mica which were in about the same condition as when chiseled from the granite of the Alleghany mountains. It was near this valley where was found one of the most interesting relics ever discovered among the works of the ancient inhabitants. It was a flat piece of copper, 6 inches in length by 4 in width, artistically wrought, with the form of an elephant represented in harness engraved upon it, and a sort of breast collar, with tugs on either side, which extended past the hips. The great amount of copper implements and blocks of mica that have been found, contradicts the theory of Mr Squire, that the tumuli located in western New York are not the work of the mound builders. I am satisfied, beyond a doubt, that

the Indian races never mined for mica or copper, neither did they bury either of these articles with the remains of their distinguished dead.—*Larkin*, p. 19

The circumstance of the Conewango and the Red House valleys being on and near the different routes to the southern rivers may be the cause of the lavish distribution of copper in those sections.—*Larkin*, p. 20

He gave an account of the demolition of a large tumulus in the town of Cold Spring about 1820, as told him by the old Seneca chief, Gov. Blacksnake:

Great quantities of relics, such as gorgets, flint axes, arrowheads, and a great number of copper implements artistically wrought from masses of native copper which was brought from the mines of Lake Superior, were found with the bones. . . So rich was this mound with decaying skeletons and relics of curious workmanship, that *now*, after more than 60 years have passed away, fragments of human bones, arrowheads and copper relics are found in large quantities at each successive plowing. In the spring of 1879, a few days after the ground had been plowed, in company with two boys we found 15 arrowheads, a curious piece of copper, and nearly a peck of fragments of human bones.—*Larkin*, p. 23

In speaking of Oil creek he said: "In the year 1861 I saw tools found in different places on the creek which were composed of native copper, one of which weighed several pounds. It was something like a drill, rather flat, pointed at one end and appeared to have been hardened."—*Larkin*, p. 81

Dr Larkin believed that the American elephant was tamed and used by prehistoric races. "Finding the form of an elephant engraved upon a copper relic some 6 inches long and 4 wide, in a mound on the Red House creek, in the year 1854 and represented in harness with a sort of breast collar with tugs reaching past the hips, first led me to adopt that theory."—*Larkin*, pref. The first quotation might imply that he had not seen this; the other that he himself found it. Those acquainted with native copper will at once conclude that some ingenious imposition was practised on him; one of those which every antiquarian sometimes encounters.

Fig. 47 is not so well finished as some of this type and the socket is square at the base. It is in the Bigelow collection

and was found on lot 42, Lysander, west of the village of Phoenix and Oswego river. The socket is short and the flanges rather low.

Fig. 48 is in the same collection, but came from near the Bay of Quinte, on the north shore of Lake Ontario. The finder unfortunately had ground down all irregularities. It is flat on one side, ridged on the other, with a square base. The flanges are parallel and much contracted and the socket is depressed, meeting the blade at a right angle.

Fig. 67 is a long and rather rude spear of this type, in the Kellogg collection at Plattsburg N. Y. where it was found. The socket is short and nearly as wide as the blade, with parallel incurved flanges. This kind of socket was used at a later day.

Fig. 66 is in the Kellogg collection, and was found at Clintonville in Clinton county. The general form is good but it seems unfinished. What should be the point has a broad protuberance and we might expect the removal of this in a perfect article. The shank is narrow and well worked, but is rounded at the end.

Fig. 51 is from the Martin collection in Plattsburg and was found about 2 miles northeast of that place on a sandy ridge at the head of Cumberland bay. Mr Martin's account follows: "The ridge referred to is wooded and was originally a long tongue of land between the bay and a river known as 'the creek,' whose course was artificially changed some 50 years ago. This implement shows lamination at the base. It is somewhat weathered and is green on most of the surface. A cross section is a square, except for about an inch from the point, where it is round." He called it a borer or awl and it may be compared with Mr Frey's shorter awl in fig. 17. This is very large beside that, being 7¼ inches long. It is a rare form in New York and the finest yet reported. The writer is much indebted to Mr Kellogg and Mr Martin for figures of their fine articles.

After describing the foregoing the writer obtained a few other illustrations from various parts of New York. For some of these he is indebted to Mr C. C. Willoughby, assistant curator of the Peabody museum, Cambridge Mass. Fig. 171 is a native copper

ax or broad gouge from Avon N. Y. given to that museum by Dr William Nisbert. This form seems more common in the Genesee valley and that of the Susquehanna than elsewhere. The general form is that of the ax, but the edge is slightly hollowed, as will be seen in one of the sections. Fig. 177 shows a piece of native copper given by Dr Nisbert and coming from the same place. It has been hammered into a rude celtlike form but has not been finished. Its importance is in this lack of completion, showing that some native copper articles may have been made here. Very few of such fragments have been found.

Fig. 173 is from an article entitled "The mound-builders," by W. L. Stone, in the September number of the *Magazine of American history*, 1878, p. 532. It is of a spearhead found in 1876, near the outlet of Saratoga lake and north of Moon's Lake house, by J. W. Coit. Fig. 174 is from the same article and is a figure of a similar but larger spearhead. This was found the same year by Horace Kelly, 2 miles up the lake on the Ramsdill farm. The point has been broken off. Both these slender spearheads have pointed tangs and are typical specimens.

In the same article Mr Kelly is credited with finding another fine spearhead at Ramsdill's cove on Saratoga lake. No description or figure of this is given but Mr Stone said it was tinged with red, apparently vermilion. If this were the case the article would be modern. Another curious find by the same person was a skull, colored on each side by verdigris. From this Mr Stone inferred the use of copper earrings. His article has some interesting statements and curious conclusions. Considering its sparse population the region about Saratoga and Lake Champlain has been unusually prolific in native copper articles. It is probable they were brought directly from Lake Superior, through the Georgian bay and Ottawa river to the St Lawrence, and thence into Lake Champlain. This was an early and well known route.

Fig. 172 is a fine and broad spearhead of native copper from a drawing by Mr Van Epps, made Aug. 1, 1901. It was found in Saratoga county many years ago and now belongs to William T. Becker of Schenectady. In this specimen the broad tang is quite short and by itself would have afforded a slight hold to the shaft.

This made necessary a notch on each side near the base. The reverse is flat and the ridged side is shown, with the usual green corrosion and hammered streaks so commonly found. He described these as a "threadlike veining of the copper, with a smooth, polished surface, though with a rich patina. In fact, this side of the blade is a vivid green of beautiful tint. The other side is smooth, unpitted, and blotched yellow and green." These are frequent features of these implements.

Two small axes or celts of native copper the writer found in the fine cabinet of the Athens historical society, Pennsylvania. Fig. 175 is one of these, belonging to Dr C. H. Ott of Sayre Pa. but found at Owego N. Y., like the next. It is symmetric and well wrought. A longitudinal section is given. Fig. 176 is another of these, more irregular and like an ax. It belongs to Mr Percy L. Lang of Waverly N. Y. Both are fine and in good condition. The writer learned of no other articles of native copper near the Susquehanna and Chemung rivers, the general range being farther north. Others will probably be found but to no great extent.

Mr Van Epps sent also a figure of a fragment of a native copper ax, "found on the ridge near Edmonds house on the Vlaie," in 1875. This is in the town of Broadalbin. It now belongs to Mr E. B. Markham, Northampton N. Y. The curved cutting edge remains, 2¼ inches wide, and the fragment is a little more than that in length. He also kindly furnished a statement of native copper articles found in eastern New York but not including Lake Champlain. He commenced his descriptions in February 1894, bringing them down to November 1901, and they embrace 10 celts or axes, nine lance-shaped blades, nearly all with tangs, and an interesting find of 135 beads. His account follows:

A brief description of the celts shows four found in the town of Glenville, Schenectady co. alone. Three were apparently surface finds; the fourth was from a grave opened by a steam shovel in a gravel bank, midway between Hoffmans Ferry and Schenectady. This was described in the *American antiquarian*, March 1894, p. 110. Some years later the interesting lot of native copper beads described below was obtained from another grave in the same bank.

One celt is recorded from the vicinity of Sharon Springs, Otsego co., one from Stuyvesant, Columbia co., the latter being in the collections of the New York state museum at Albany; and two others, found quite near the latter, in the town of Schodack. These two were found about the year 1893. Another, found near Glens Falls, is listed as lot no. 203 in the catalogue of the Wagman collection, sold in Boston by Woodward, in 1886. This measured 2½ by 4½ inches.

The tenth and last to be mentioned was found on a relic strewn sand spit, jutting northward into the great Sacandaga Vlaie near Northampton, "the Fish-house," Fulton co. This is a broken portion of the usual form of native copper celt, a fragment forming a triangle, whose sides measure about 2 inches, one being the cutting edge of the implement. The fracture, which is ancient, appears to have been made with great violence, for the fragment remaining is bent, showing the effect of a torsional twist or strain. This interesting relic was found in 1874 or 1875 and is covered with a fine green patina. All of the 10, as far as can be ascertained, are of the common rectanglar form, varying but little from the dimensions of the one from Glens Falls.

The lance-shaped blades, whether used as knives, spear or arrowheads, present a greater diversity of form. Of the nine blades listed five are from Saratoga county. The remaining four are from Warren county, two of which were found near Glens Falls, one from French mountain, Queensbury, and the last from the vicinity of Lake George. Modern territorial boundaries count for nothing in archeologic science unless based on some prominent natural division of land by mountain range or water, and so it will be seen by those familiar with these localities that the whole of the blades recorded were found in a very small area.

One of those from Saratoga county is a most beautiful example of the ancient American's skill in working native copper. It is now in the collection of William T. Becker of Schenectady N. Y. It is in absolutely perfect condition, is beautifully patinated in different tints, and has the unusual feature of a deeply notched base in addition to the usual tang, which however is very short. Its length is 4¼ inches and greatest breadth 1⅜ inches. Two others of the blades listed, of the common variety with long tang, were described and figured by William L. Stone in the *American magazine of history* for September 1878. One is described by him as being bronze but this is doubtless an erroneous idea.

Closing the list of objects made by the aborigines from native copper is the find of beads numbering 135. This was made about midway between Hoffmans Ferry and Schenectady, at a gravel ridge in the town of Glenville, ½ mile from the north bank of the Mohawk river. In opening this bank several graves have been

disclosed. The one containing the beads had no other relics save a few crumbling fragments of bone, while the grave containing the copper celt, but a few yards distant, yielded quite a store of fine objects, among which were an ornamented slate tube, some awls and a hook of bone, several hundred small perforated sea-shells, and a very fine doubly perforated boat-stone, made of cave alabaster. The 135 beads, varying from ¼ to ½ of an inch in diameter, were made by coiling a pounded strip of native copper upon itself, and then by further dextrous beating bringing the lapped edge down to an almost perfect weld. Unfortunately for science this interesting find was scattered instead of being preserved intact.

On reviewing this list an interesting question is suggested. The indicated localities show that all described, with the exception of the celt from Sharon, are from the Hudson valley from Stuyvesant north to Lake George, and from the lower waters of the Sacandaga and Mohawk rivers. In fact every specimen listed, with possibly two exceptions, comes within the bounds of the ancient territory of the Mahikans or River Indians. Can we thus conclude that these were made and used by these Indians? Certainly, to my knowledge no native copper implements have been reported from any part of the Mohawk valley west of the localities mentioned. All of the numerous private collections of local material in the Mohawk valley, from Amsterdam to Utica, are absolutely barren of relics of this character. Triangular and conical arrowheads, rolled tubular beads, trinkets, etc. made from sheet copper and brass of colonial times, are quite abundant on castle and village sites on either bank of the Mohawk west from Amsterdam, but never an object of native copper has appeared. Garoga, Otsquago and Cayadutta, the three great Mohawk strongholds of precolonial time, with their myriad relics unearthed, tell us the same story—an utter absence of native copper.

In qualifying the above suggestive statement it may be said that the Palatine Bridge awl and beads are presumably of native copper, and that nowhere are native copper articles more frequent than in Clinton county near Lake Champlain. They seem everywhere to have been lost in travel and they are rare in the Mohawk valley because that was not a favorite route till the Mohawks came there late in the 16th century. Even then the river was little used west of Canajoharie for a long time.

Several of the articles mentioned by Mr Van Epps are illustrated in this bulletin, and can be compared with his account.

His ability and experience are well known, and these have been of great service in the present work.

Among the articles of native copper not figured here is one formerly in the state museum, from H. Van Rensselaer's farm near Ogdensburg. It is classed as a copper pickax. A fine triangular copper celt also belongs to the museum which came from Stuyvesant, Columbia co. One article of native copper was found on D. F. Shafer's farm, Schoharie. Mr Henry Woodworth of East Watertown has a fine spear of this material 4 inches long. A neighbor found a larger one which he unwisely polished. Mr W. P. Letchworth of Portage says: "I once had in my collection an ancient copper hatchet, excavated near Silver Creek N. Y. which disappeared in a loan exhibition held in Buffalo many years ago."

Copper implements have been reported at East Aurora, but most relics are recent there and these may be inferred to be the same. At the opening of the Cambria ossuary in 1823 copper and iron implements were found with flint arrowheads and pottery. Though of an early date the copper there was probably not native.

The Wagman collection was sold at auction in 1886. It was made up of articles found not far from Saratoga and in it were three of native copper. One was described as a combined spearhead and bodkin, probably a spear with a long and sharp tang. This was from Glens Falls and measured 6½ inches by ⅞ inch. An arrowhead from the same place was 4½ by 2½ inches, which is unusually wide for such an article. An elliptic and pointed spearhead was 6 by 1¼ inches. In the *Smithsonian report* for 1879, Mr N. Cole mentioned a native copper spear, found near West mountain, Warren co.

Copper articles were found in opening a mound in Mount Morris in 1835. These have since been reported as of brass, including brass kettles. Mr Hough mentioned a native copper chisel in Ellisburg, Jefferson co. Mr T. A. Cheney said, in describing a circular work and its relics on the east bank of the Allegany river:

Among these were spearheads some 6 inches in length with double barbs upon each side and formed from native masses of copper. . . Fig. 9 represents a copper arrowhead of fine finish which was disclosed within the inclosure. It is stated that spearheads, hatchets, etc. of iron, much oxidized by exposure, had been observed within this ancient work. None came to my notice.—*Cheney*, p. 49

The arrowhead represented is large but otherwise like those of European copper found on Iroquois sites of the 17th century. It is possible that native copper articles were found with this but Mr Cheney did not say he saw them. Others have reported modern copper arrows from forts on Cattaraugus creek, not found by them and therefore subject to doubt. They may have been used by the Eries in the 17th century.

Besides 135 tempered copper beads found in a grave 5 miles northwest of Schenectady, Mr Van Epps reported a native copper ax in the *American antiquarian* for 1894, found 20 years earlier. Fragmentary copper occurs in a few places. Most of the native copper implements now known in New York have been gathered within a quarter of a century and there may be many unreported now in private hands. Mr J. W. Nelson reported a fragment of native copper, 3 by 5 inches, with silver veins, from Deming's point, mouth of Matteawan creek, and a double-pointed knife 4 inches long. Copper spears have been doubtfully reported from Fredonia.

In the summer of 1901 Mr Lorimer Ogden, of Penn Yan, obtained a fine copper spear, 6 inches long, but no further description of this has been received, nor any notes of locality. The find is quite unusual for that section of New York, as such articles seem very rare in the lake region of the central and western parts of the state.

A fine celt of native copper was received too late for illustration, and is now in the Bigelow collection. It presents no unusual features, but has the black lines, corrosion and verdigris common to all articles of the kind. The general thickness is $\frac{3}{8}$ of an inch, gradually sloping on one side to the top, but more abruptly curving on both sides to the broad cutting edge.

One lateral edge is straight; the other curves, so that the width, which is $\frac{7}{8}$ of an inch at the top, becomes an inch at the center and $1\frac{1}{2}$ inches at the chisel edge. This edge is angularly curved, and quite sharp. Like most of the Bigelow articles it comes from the vicinity of the present owner's home, having been recently found near Three River Point, at the junction of the Seneca, Oneida and Oswego rivers. That part of New York has proved peculiarly rich in native copper, perhaps from its navigable waters and fine fishing grounds.

Among Canadian articles not yet found in New York is a native copper spike, found with two others and some copper beads on Wolfe island. It is pointed, slightly curved, angular, and has the head bent over so as to form an eye. This is $\frac{1}{4}$ inch in diameter and $3\frac{3}{8}$ inches long.

Another is a very slender one-sided spear or knife, with a tang, above which it has its greatest width of a little over an inch, tapering thence to the point. The other edge is 14 inches long. This came from St Joseph's island.

The most remarkable is a broad, thin, and much curved copper knife, the concave edge of which has 15 equidistant rounded teeth. It is a little over 13 inches long and nearly 3 wide. Part of the wrapper of beaver skin still adheres to it. This came from Midland City, the site of an old Huron town, giving it an age of at least 260 years.

In Wisconsin native copper articles much like the rolled arrowpoints of New York have been found, but they are heavier and the edges do not meet. The copper fishhooks there differ but little in appearance from the recent Iroquois forms. The copper crescents of that state are broad and curved plates, with sharp projections at each end of the concave edge. A similar ornament or implement in the national museum tapers regularly from near the center to each end and has no projections. It was found in Maryland and measures $8\frac{1}{4}$ inches from point to point. Another in the same museum came from Canada. This is wider, more curved, and is 8 inches across. A very slender tool in the same collection is also from Canada. It is $11\frac{3}{8}$ inches

long and the greatest width is at the base, where it is $\frac{7}{8}$ inch wide, tapering thence nearly to the point. Flanges extend halfway on each side.

Recent copper and brass implements

The New York aborigines were not slow to see the advantages of metallic articles of all kinds, whatever they may have had before Hudson's voyage. His account of their copper tobacco pipes may be compared with incidents in Gosnold's voyage a little before, along the New England coast. It is by no means improbable that some European articles had already found their way to them, but opportunities at once became greater. The Dutch soon followed Hudson's lead to the upper waters of the river, and early trade may be said to have commenced there rather than in the harbor of New York. We may dismiss the mythic Tawasentha council as far as the Iroquois are concerned. Their eastern boundary reached only the west line of Albany county, and the hostile Mahikans held the west bank of the river till Van Rensselaer purchased the land on both sides. It is quite likely the Mohawks soon contrived to trade on or near the river, but they had no treaty with the Dutch when Corlaer (Arent Van Curler) visited them in 1642, nor is there any evidence of any till 1645. Adriaen Van der Donck said: "In the year 1645 we were employed with the officers and rulers of the colony of Rensselaerwyck in negotiating a treaty of peace with the Maquas, who were and still are the strongest and fiercest Indian nation of the country; whereat the Director general William Kieft on the one part, and the chiefs of the Indian nations of the neighboring country on the other part, attended." The Mahikans had then removed to New England.

Preliminary to this first formal council with the Mohawks, Corlaer said in 1642, he "brought presents there, and asked that we should live as good neighbors, and that they should do no harm to either the colonists or their cattle, to all of which the savages at the three castles gratefully agreed." Three years later the treaty was made. The Mohawks of the first castle may

have referred to Corlaer's informal visit when they said, Sep. 24, 1659: "Brothers, 16 years have now passed since we made the first treaty of friendship and brotherhood between you and all the Dutch, whom we then joined together with an iron chain. Since that time it has never been broken either by us or by our brothers and we have no fear that it will be broken by either side."

It would be easy to bring other proof that this supposed early Tawasentha council with the Iroquois was never held, but the practical fact remains that Indian trade began at Fort Orange or Albany, and that it speedily penetrated farther. The Minquas, or Susquehannas, lived on the lower waters of the Susquehanna river and were kindred to the Iroquois. They were visited by Capt. Cornelis Hendricksen, who made a report of his discoveries, Aug. 18, 1616. Among other things, "he also traded for, and bought from the inhabitants, the Minquaes, three persons, being people belonging to this company; which three persons were employed in the service of the Mohawks and Machicans; giving for them kettles, beads and merchandise." It has been reasonably supposed that these Dutch traders among the Mohawks were taken prisoners by their enemies, the Minquas, and that on their knowledge of the country the maps of 1614 and 1616 were partially founded. Farther we know not.

War between the Mahikans and Mohawks interfered with the Albany trade at times and in these hostilities the Dutch became involved in 1625. The commander at Fort Orange assisted the Mahikans, but the Mohawks beat the combined party and killed him and six of his men, cooking and eating one of them and sending portions to their villages to show they were superior to the white men. Yet the Mohawks bore no malice. Peter Barentsen visited them a few days later and they said they would not have injured the Dutch had they not meddled with them. After this hostile episode there was no farther trouble.

The Dutch did not at once sell guns to the Iroquois and were shrewd enough to withhold them from the River Indians when furnishing the others, but whether they sold arrowheads to both

may be a question. The arrowheads found with other things in an Indian grave at Fall River, on which Longfellow founded his well known ballad, are precisely like those found on most recent Iroquois sites. These are generally a long triangle with various other features. For convenience those of iron will be placed with them here. Most of these are cut from thin sheet iron or brass, commonly with perforations by which they were securely bound to the shafts. Parts of these often remain, having been preserved by the salts of the copper. As shreds and large fragments of sheet copper are frequent on Iroquois sites it is probable that many arrowheads and ornaments were made on the spot. Sometimes an old brass kettle was used in this way.

Fig. 46 is a long spearhead from Cattaraugus creek, made from an old brass kettle. At the base the edges are rolled over so as to form a socket. This is the largest the writer has seen.

Fig. 6 comes from Cayuga county and is reduced in size. It is made of sheet copper and is 1⅝ inches long. There is a perforation by which a part of the shaft remains attached by sinews. Fig. 70 is an unusually long and rather rough copper arrowhead from Indian hill, Pompey. This was the town of 1654, and these triangular arrowheads have been frequent there. It was occupied till 1682. This is unperforated. Mr David Boyle calls these ghost arrows.

Fig. 82 is in the collection of Mr W. L. Hildburgh and was found in Oneida county near Oneida lake. It is of rolled copper, pentagonal, with one perforation and another begun. This form is rare. Fig. 83 is similar but longer in proportion and has a very small perforation midway. It is in the same collection, and from Livingston county. Fig. 84 is in the same cabinet, and has a stem, rather a rare feature in this class. This is from Oneida county.

Fig. 63 is a triangular arrowhead with indented and undulating base. It is not perforated and comes from Indian Castle, north of Watervale, where copper arrowheads have been abun-

dant. This was occupied in 1677. Fig. 103 is a long and perforated triangular arrowhead, also from Pompey. Fig. 111 is of a different character, being of yellow sheet brass, stemmed and barbed and with notches in the edges. This is from the fort south of Pompey Center, occupied about 1640.

Fig. 117 is from Cayuga county and was found in 1888. It has no perforation but part of the shaft remains attached, being bound below the metal. Mr W. W. Adams, the finder, called it a brass arrowhead.

Fig. 113 is of copper and from the Sheldon fort, lot 69, Pompey, probably occupied about 1630. It differs from most in having the two long edges slightly convex. Fig. 129 is one of three triangular arrowheads found by the writer at Indian hill, Pompey, in 1886. This is perforated but the others are not. Fig. 133 is of rarer material, being of thin iron. It is triangular, with indented base, and having one of the long edges irregular. This came from Indian Castle, Pompey. Fig. 134 is from the same place and is of copper. The perforation is central and long, and the ends of the base have a slight upward curve. Fig. 140 is a long triangular brass arrowhead from the fort south of Pompey Center, having convex edges. Most of the articles from this site are in the Vail collection.

Fig. 141 is a brass arrowhead from an Oneida village site near Munnsville, Madison co. It has a sharp angular indentation in the base and another in one lateral edge. Fig. 142 is another of sheet brass, found in 1879 east of the Oswego river at Phoenix. It is barbed and stemmed.

Fig. 143 was drawn from one taken from a grave near Amsterdam N. Y. and in the possession of Mr Le Grand S. Strong. It has an indented base and a square perforation. This is unusual though not unique. Mr Grider gave the same feature to two others. Fig. 144 is one of these, from the same place, and differs from the last in its pentagonal form. Fig. 159 is the third of these, and is much larger than the others.

Fig. 157 is a large and fine brass arrowhead, stemmed and barbed. It is from Stone Arabia and is in the Richmond collec-

tion. Fig. 160 is a copper arrow with angularly indented base, and is in the same cabinet. It was from the Nellis farm near Palatine Church, and with it is a larger one with slightly indented base. Fig. 164 is a triangular brass arrowhead from the Sheldon fort, Pompey. This is not large, and the base is convex. Fig. 58 is from the same site and like the last.

Fig. 149 is another triangular arrowhead from Indian hill, Pompey. It has a central perforation and an indented base. Fig. 150 is from the same site and is similar except in having a straight base. Fig. 152 is a large triangular arrowhead, one edge of which is convex. The perforation is central. It is from Happy hollow, west of Canajoharie. Fig. 153 is a narrow triangular arrowhead from Indian hill, Pompey. The base is slightly convex.

Fig. 86 is a very neat little brass arrowhead, found near Oneida lake, and of unusual form. There are slight notches in the lateral edges of the sloping base and the cutting edges are a little convex.

Fig. 151 is of quite a different type. There is a short stem with an expanded base, and the shoulders are almost barbs. The lateral edges are beveled and sharp and there are several long incisions on the flat surface. The point is broadly rounded, and it may be one of the later steel arrowheads. It is in the collection of the Onondaga historical association, but without locality. Fig. 54 has a similar base, is of iron or steel, and not unlike the last in general character. It is beveled from the center and there is a large perforation on each side above the shoulders. The edges of these have been hammered down. It was found at Baldwinsville in 1880 and is in the Hamill collection. Fig. 184 is a fine and curious iron arrowhead, with notches. It is in the Coats collection and from the Onaghee site.

There is another class of recent copper arrowheads barely separated from ornaments. A triangular and rather long piece of sheet copper was rolled into a slender cone. If it was to be used as a bangle, with a tuft of colored hair inserted, the narrow

point was left a little open for suspension. If an arrowhead was desired, it was rolled tightly so as to make a sharp point. Fig. 85 shows one of the latter, in the Hildburgh collection, which has part of the slender shaft remaining. It was found in Livingston county, where the form is frequent. Fig. 148 is another, belonging to G. W. Chapin of Fonda N. Y. and was found on Briggs creek, north of the Mohawk river. The writer has seen many on the Pompey, Owego and Cayuga sites, and they abound in Ontario county. Fig. 183 is a fine example, recently found at Indian hill in Pompey.

In these selections from a great number of specimens and figures, it will be seen that the Iroquois changed the material but not the form of the arrowhead. Probably nine out of 10 are simply long triangles, the favorite Iroquois form when they used stone. The rolled and cylindric examples do not differ much in form from the earlier ones made of horn. Those with stems are everywhere rare, and some were not made by the Indians, but sold to them or given as presents. Most persons are familiar with the iron arrowheads used by our western tribes but they are hardly a new feature of savage life. Some Abenakis came from New England to visit Count Frontenac in 1691 and proffer him their aid. In reply he told them they might have all the iron arrowheads they could carry away. This shows he had a constant and abundant supply.

Brass kettles

The earthen pot survived the coming of the brass kettle for a generation, for poor Indians could make the former when unable to buy the latter. The advantages of the metallic vessel were too great, however, to be foregone except in case of need. It was light, durable and convenient, and was at once a favorite. Even to the happy hunting grounds its spirit could go with the Indian warrior. Hence came a curious custom among the Hurons of Canada, always in early days noted as thieves. The articles were valuable and the graves might be robbed. The safeguard was to cut a hole in the bottom with an axe, which

ruined it for earthly use but not for spiritual. Nearly all Canadian vessels of that period are thus marred.

It was not so in New York. Fragments of vessels are found, but an incredible number of perfect ones have been exhumed, many of which afterward did faithful service in the kitchens of pioneers. In graves they often contain traces of food, charred corn, dried grapes, chestnuts, raspberry seeds and other things.

Large vessels might be used in villages, but travelers preferred those which were small and light. For convenience these were sometimes placed in caches or hid in trees. Thus, when Cammerhoff and Zeisberger were at Skaneateles July 21, 1750, they said: "There we found the kettle which we had concealed when we passed here the last time."

The lack of this kettle, while at Onondaga, gave them occasion to note another use. A war party was about to set forth and on the evening of July 11 they were invited to a farewell feast:

> The repast was held in the house of the chief and all was conducted in a very ceremonious manner. Every one brought his kettle. The chiefs sat together and our seats were in the midst. After the usual ceremonies the meal was served by two servants. They had boiled a whole pig with Indian corn and the servants continued helping the guests until the supply was exhausted. As we had no kettle or dish, they furnished us with a kettle and filled it very full. We were still hungry from our long fast and ate the food with great relish. When we had emptied our kettle they filled it again and we took it home with us.—*Cammerhoff*

At the 10 days dead feast and other like occasions, the Onondagas still carry home parts of the feast in their tin pails, but they do not now eat from them. In old times it was customary for all to carry their bark dishes and wooden spoons. When Conrad Weiser and John Bartram were at Onondaga in 1743 the latter gives the impression that the feast was more in common. He said: "After 4 o'clock we all dined together upon four great kettles of *Indian* corn soop, which we soon emptied." A few days before Weiser was at a feast with 18 Onondaga chiefs. Several songs opened this, followed by the emptying of a two gallon keg of rum in mutual healths. "After that the

kettle was handed round with a wooden spoon in it; every one took so much as he pleased." This may have been placed in his own small kettle.

In 1684 La Salle wanted 2000 pounds of small brass kettles at Fort Frontenac, costing 1 livre, 5 sous, a pound. These would sell for 4 francs a pound, yielding a great profit. The English and Dutch sold these also but included them among presents. In 1693 Gov. Fletcher gave the Mohawks 24 brass kettles for cooking to replace those the French had destroyed in February. Some of 2 or 3 pounds weight were among the presents of the following year. They prized small brass kettles but large ones were needed for public occasions. When Schuyler and Livingston came to Onondaga in 1700 the Indians, "according to their custom, hung over a great kettle of hasty pudding made of parch'd Indian meal, and sent it us." The great kettle is now of iron but is still a feature of New York reservation life.

As one feature of public gatherings and great occasions the kettle became symbolic. When Frontenac was preparing to invade Onondaga in 1696, he spoke to his friendly Indians about "the Great Kettle from which the whole world will take what it wants to keep alive the war unto the end. Be not impatient; that Kettle has not yet boiled; it will boil soon. Then will Onontio invite all his children to the feast and they will find wherewithal to fill them. The tears and the submissions of the Iroquois will no longer be received as in times past. They have overflowed the measure; the patience of the common father is exhausted; their destruction is inevitable."—*O'Callaghan*, 9:645

Dablon described the general war feast at Onondaga in chapter 10 of the *Relation* of 1656, and part of this is quoted here:

We saw in the latter part of January the ceremony which takes place every winter in their preparations for war, and which serves to stimulate their courage for the approaching conflict. First of all the war kettle, as they call it, is hung over the fire as early as the preceding autumn, in order that each of the allies may have the opportunity to throw in some precious morsel to be kept cooking through the winter; that is to say, in order that they may contribute to the enterprise which they are planning. The kettle having boiled steadily to the

month of February, a great number of the hunters of Sonnontouan (Seneca) and of Oiogoen, (Cayuga) having repaired hither, made the war feast, which lasted several nights. . . The Father (Chaumonot) was invited to put something into the kettle to make it better. He told them that that was certainly his desire; and accommodating himself to their customs, he assured them that the French would put some powder under this kettle, which pleased them greatly.

To upset this kettle was to abandon warlike plans. To boil the flesh of an enemy in it was often metaphoric, but much more frequently literal. William L. Stone quotes from Ramsay's *History of the revolution* a passage apparently referring to Guy Johnson's council with the Indians at Oswego in 1775:

Colonel Johnson had repeated conferences with the Indians and endeavoured to influence them to take up the hatchet, but they steadily refused. In order to gain this cooperation, he invited them to feast on a Bostonian and to drink his blood. This, in the Indian style, meant no more than to partake of a roasted ox and a pipe of wine at a public entertainment, which was given on design to influence them to cooperate with the British troops. The colonial patriots affected to understand it in its literal sense.—*Stone*, 1:88

It may be noted that Was-to-heh-no is still the Onondaga name for the people of the United States, being the nearest approach they could make to pronouncing "Bostonian" a century ago. The figurative use of many terms has been often explained but the early Iroquois had a well founded reputation for cannibal tastes. The eastern Indians called them Man-eaters.

Though the subject of cooking and serving meals is connected with that of the utensils employed, a bare reference may serve here. Not much time was wasted in preparing food till those later days when the kettle was always over the fire. Some ate directly from this; others used small kettles, bark dishes and wooden spoons. Indians had their changing and local fashions even as we do. Their few vegetables and abundant game gave them all the variety they required. Greatly prized were the three supporters of life, corn, beans and squashes, and of these they have pretty stories to tell. In agriculture the colonists learned some useful lessons from them, and the French mis-

sionaries preferred meal ground with the wooden pestle and mortar to that from their own hand mills. In plentiful times they reveled; in times of dearth they ate anything they could. In Indian corn they left a priceless legacy to the land.

A few illustrations of brass kettles will be given, as well as of some parts. They were serviceable after their original use was gone, being formed into arrowheads, knives, saws and ornaments of many kinds. Examples of some of these secondary uses will be given.

Fig. 158 is a much reduced figure of one out of many kettles found in Cayuga county in 1885-86. Fig. 155 is another of actual size, in the collection of Mr C. F. Moseley, Bergen N. Y. It is from Honeoye Falls, where many similar ones have been found. Fig. 147 is another from the same place, of actual size. The ears are of different forms. This one is in the Dann collection, is not corroded, and is in fine condition. Another, much like this, is from the same place, and now in the state museum. It is $5\frac{3}{4}$ inches in diameter, and almost 3 inches deep. One with it is an inch wider and a very little deeper. One found 3 feet underground, at the junction of Wood and Fish creeks, near Oneida lake, has a top diameter of $5\frac{1}{2}$ inches, bottom $4\frac{1}{8}$ and a depth of 3 inches. This was much corroded. The rim was rolled but not wired, and the ears for the bail were cut out and riveted in place. It was close to the face of a skeleton and bottom side up. Other relics were found several feet deeper, but the shifting sand made the original depth doubtful.

Brass tobacco boxes were among the presents of 1694, and these are occasionally found. They are circular and flat and were sometimes used to hold paint. Tomahawks are frequently made of brass, with a steel edge.

While most of a broken brass kettle could be used, the ears were not available, and so are sometimes found in a perfect condition but detached from the vessel. Fig. 128 shows one of these which forms a thick loop, with the ends riveted to the vessel. This is from Indian hill, Pompey, where this form is common, and is of actual size. Fig. 156 is also of actual size, the rivets

remaining. It is made of a flat plate of brass about as thick as the kettle, inside of which it was placed. The corners of the plate are bent over. This is from the fort south of Pompey Center, making it 15 or 20 years older than the last.

Copper spoons are rather rare, the Indians preferring the wooden ones which they made with so much taste and skill. Fig. 137 was drawn by Mr R. A. Grider from a large copper spoon belonging to Mr D. I. Devoe of Fort Plain N. Y. It was made from part of a kettle, and was found in a grave. Fig. 138 is a profile view of another made of pewter, and fig. 139 is a full view of the same. The form is much like that of the wooden spoon but lacks the ornament at the top of the handle, which is bent over. This was found in a grave in Cayuga county with a pewter mug containing 44 French coins, dated from 1642 to 1656. Some of the earlier dates may be doubtful.

Fig. 131 is a flat copper spatula, found on the Odell farm, lot 3, Van Buren, on the south side of Seneca river. It has been hammered into shape, and is rather smooth. This may have been once nearly on a plane but is now considerably bent. Fig. 163 is much like the last in outline but has a longer handle, thickened at the end. It is of iron and was found in the town of Fleming in 1887.

Among the presents recommended for the Five Nations in 1694, were "50. Brass Kettles of two, three, & four pound a p^{ce} thin beaten and light to Carry when they go a hunting, or to war if the Continue."—*O'Callaghan* 4:126. The high value the Indians placed on "small brass kettles" was noted in 1696. Among the presents of that year were 30 small and 14 large kettles.

For trade purposes they were often brought to the Indians in graded sizes. Mr J. V. H. Clark mentioned some thus arranged in Pompey. "Mr David Hinsdale found a *nest* of brass kettles, the largest of which would hold two pails full, and the smallest about three pints. They were all bailed, ready for use, and some of the smaller ones were used in Dr Western's family and Mr Hinsdale's family for several years. The larger ones,

being on the outside, were considerably corroded by time and exposure and were unfit for use."—*Clark*, 2:260

Squier mentioned a curious burial around a kettle, which may be credited to the Neutral nation. A large number of skeletons were found together in the town of Black Rock. "They were arranged in a circle, with their heads radiating from a large copper kettle which had been placed in the center and filled with bones. Various implements both of modern and remote date had been placed beside the skeletons."—*Squier*, p. 100

The brass kettles which he describes and figures from the Canadian ossuaries are quite different in some respects from those of New York. The ears and bails project far out from the sides in a very clumsy way and the kettles held from 6 to 16 gallons. As these were undoubtedly French, those of New York may show the prevalent English and Dutch forms in the 17th century.

Metallic pipes

Roger Williams's statement has been given regarding the quickness with which the New England Indians learned to cast metals, even in the form of pipes. Their ability to cast brass may be doubted. When the writer was a child every hunter cast his own bullets, and he has done the same. Bullet molds occur on Iroquois sites 250 years old. Like things were a part of household economy. In the general Bigelow collection is a mold for casting pewter spoons, much in use in pioneer days by those who could not afford silver, then a foreign commodity. Were the old spoons bent and battered? They went into the ladle and mold and came forth in pristine beauty.

Though Hudson said he saw copper pipes in New York in 1609, none of these are known, nor are metallic pipes common. Those found on Indian sites were probably made by white men. Pewter and lead were easily melted; not so iron and brass. So bars of lead were often given to the Indians at treaties and are sometimes found on their village sites. These were mostly used for bullets, but some were formed into rude ornaments, to be noted later. In case of necessity the lead ornament or pipe might take the form of balls for the gun.

Fig. 79 is the bowl of a pewter pipe in the Hildburgh collection, found in Livingston county. The bowl is cylindric and it has a broad and thin rim. Another as broad again, with a wood and copper bowl, is in the same collection, but is almost destroyed. This is from Oneida Valley, whence comes another of the same materials and in fair condition. This has an expanding bowl with raised angles.

Fig. 80 is a slender trumpet-form pipe of brass in the Richmond collection, found on the Briggs farm, town of Mohawk N. Y. Fig. 104 is a large and rude iron pipebowl from the Rose hill farm in Seneca county, on the east bank of Seneca lake. It has a projecting rim and is angular.

Fig. 127 is a curious angular lead pipe in the state museum, with a bold platform projection in front of the top of the bowl. This was obtained by Mr J. S. Twining in Jefferson county. Fig. 130 is a massive pipe of pewter or lead and of simple form, found in the town of Schroeppel, a little north of Oneida river. The edge of the bowl has been battered. Fig. 145 is a fine but short lead pipe, found near the surface of the grave in Fleming where the pewter mug was obtained. Fig. 146 is an equally fine pipe of the same material, found in Rome N. Y. The stem is quite slender.

Fig. 132 is an iron pipe of modern pattern, found in the town of Scipioville. It is partly brazed, and but 5 inches of the long stem remain. Fig. 136 is a fine pewter pipe, found near Mapleton, on the site of Upper Cayuga. Part only of the stem is shown here, but the extreme length of the pipe is 9½ inches.

Fig. 182 is from Oneida Valley and is in the Hildburgh collection. The owner describes it as made of copper, pewter and wood. The form is unique. Fig. 181 is a fine example of a small iron pipe, found in Jefferson county and belonging to Dr Getman. It is well made and preserved, and has a knob at the bottom of the bowl and the end of the stem. The stem is but little longer than the bowl.

Fig. 180 is a reproduction of one sent the writer by Walter C. Wyman of Chicago, and represents an interesting relic of two

prominent men of New York. It is of silver with the simple inscription on the bowl: "Presented by Governor Tompkins to Skenandoah." De Witt Clinton visited the old chief at Oneida in 1810 and said: "He is entirely blind but his hair is not gray. He smokes, and can converse a little in English. He was highly delighted with a silver pipe that was given him by Governor Tompkins." The latter filled his office from 1807 to 1817, and the pipe is now nearly a century old. Mr Wyman said: "The lettering is very much rubbed but is legible. The pipe was obtained with the wampum belt of the Oneida treaties, directly from old Skenandoah, the chief of the Oneidas in Wisconsin, who died three years ago. He was the grandson of the owner of the pipe and was about 90 when he died."

Mr Jeptha R. Simms describes another of these New York silver pipes in the following words:

Oct. 28, 1867, I had a visit from Rev. Robert Jones Roberts, a young English missionary to the Six Nation Indians at Newport, province of Ontario, Canada. He was accompanied by G. H. M. Johnson—On-wan-on-shy-son—one of the principal Indian chiefs of that province, who claimed to obtain his name by descent from Sir William Johnson. . . He carried with him a pipe which had descended through several generations of sachems, and had become among them an evidence to its bearer of his dignified position. On the plate under its stem, next the bowl, was engraved the history of its origin, reading upon the right side, from the mouth, "As a testimony of their sincere esteem;" and on its reverse, "To the Mohawk Indians, from the Nine Partners of the tract near Schoharie, granted in 1769." This pipe is of pure silver and weighs four ounces avoirdupois. It is of goodly proportions, with a bowl 2 inches deep; from which the stem measures 18½ inches. An ornamental plate, perhaps an inch wide, extends 5 inches from the bowl, bearing the inscription above named. From this plate to within 4 inches of the end of the stem, is a small silver chain. On the front of the bowl stand the figures of a white man and an Indian, holding a chain in their right hands; the latter having in his left hand a pipe from which he is smoking. This relic is sacredly treasured among the Indians.—*Simms*, p. 43

Mr Simms gave a good figure of this interesting article. The Schoharie valley belonged to the Mohawks, and the original Nine Partners' great and little patents were in Dutchess county,

and dated in 1697 and 1706. These partners were not the same. Several patents of Otsego and Schoharie lands were made in 1769.

After the above was written the writer figured a fine pewter pipe belonging to Mr Addison Pease of Fleming, and found at that place. It is of a modern form, with ample bowl and in good condition.

More of these might be shown, but they differ little in form, even when combined with wood or stone. Such combinations were frequent. In a paper in the *American antiquarian* for 1879 Mr Edwin A. Barber figured several Dutch and Swiss iron pipes and a rude copper pipe from Pennsylvania. He also quoted a statement about the pipe of Capt. Miles Standish, used by him till his death. It was "a little iron affair of about the size and shape of a common clay pipe." Mr Barber thought this was made in Holland. Those in New York may be over 200 years old. This eminent authority concludes "that we have no positive proof that pipes were in use in Europe before the Columbian discovery of America; but if it can be shown that such was undoubtedly the case, it is reasonably certain that such objects were employed in medicinal remedies or for purposes of fumigation."

It was customary to present large quantities of pipes at Indian councils. Among the presents in 1696 were "1 grose of tobacco pipes, wood & tinn," and sometimes casks of pipes were given. The study of European pipes used by the Indians of New York has proved of much interest. They came in at quite an early day.

Trade axes

One of the earliest iron implements that found its way into the interior of New York is known as the trade ax. It usually has a broad edge for cutting, but is narrow below the socket for the handle. This was made by bending over the upper part of the flat iron plate, forming an elliptic opening. They are of all sizes, and quite frequently are stamped with three circles, each inclosing a cross. Sometimes the cross has a sec-

ond bar. The circles vary from one to three, never exceeding the latter number. Many are unstamped. They occur in large numbers in some parts of Canada and New York. Hundreds have been found on Cazenovia creek in Erie county. Large numbers on Cattaraugus creek, near the lake, kept the early blacksmiths supplied with good material, and Mr Obed Edson recorded large finds in Erie and Chautauqua counties. Several hundred pounds of these were found on M. B. Crooks's farm, 2 miles from East Aurora. Miles Bristol paid for two years tillage of his orchard lot with the axes he found at the village of Lima. In another place enough of these were obtained to equip an early sawmill, and Cayuga, Madison, Onondaga and Ontario counties have been equally prolific. After a century's gathering the crop is not exhausted. Squier said of these: "Thousands are found in the western counties of the state."

Their early introduction has been already noted, Champlain seeing them here in 1609. One or two have been found near the prehistoric fort in the town of Minden, but not of late years at least within the wall. Squier said that brass kettles and European articles were found inside the bank, but this is usually thought an error. In another place the evidence is clearer, and fig. 87 is probably one of the oldest to which a date can be given. It is 7 inches long and is stamped with two circles of unusual character. The cross is not of the common type, and there are very small circles in three angles of the limbs. This is in a collection at Cazenovia N. Y. with another much larger, and regarding both Mr J. T. E. Burr writes: "The iron axes are from the fort on the Nichols farm, on the Mile Strip in Fenner. I know when they were found, and assure you they are genuine and properly located." The larger one is 8 inches long, with a cutting edge of 4½ inches. It has three circles close together but each cross has a double bar. The socket is bent and broken.

It is probable these were used in the siege of the Oneida fort in 1615 but whether they were brought by Champlain's Indians or already owned by the Oneidas is conjectural. The

latter removed their town soon after, and when Corlaer visited them in December 1634, a chief told him that "the Frenchmen had come thither to trade with six men, and had given him good gifts, because they had been trading in this river with six men in the month of August of this year. We saw very good axes to cut the underwood." They saw razors also.

In this case it is quite probable that by the river they meant the St Lawrence, rather than any stream in the country of the Oneidas. It was easy to misunderstand.

In the pictures accompanying the account of the nine Iroquois tribes or clans in 1666, the Turtle and the Beaver carry the typical trade ax, but the Eagle has a hatchet expanding equally on each side. Wooden clubs were at first called tomahawks, but after a time axes were known by this name. Taking up and laying down the hatchet became terms for war and peace, modified to suit the occasion. According to Colden the expression was enforced by acts at times. He relates the proceedings at a council in Albany in 1684. Speeches and explanations had been made to avert hostilities. "Then the axes were buried in the southeast end of the courtyard, and the Indians threw the earth upon them." The council was really held in 1681.

When war was unsuccessful the Indians said the ax was poor or broken, and some battles have been known by this name. Axes were figured on or attached to war belts. In 1692 Tataconicere, an Oneida at a French mission post in Canada, learned that the wife of the Onondaga chief, Black Kettle, was trying to escape. He at once killed her, and "struck his hatchet into the gate as a sign that he would not grant pardon to any one." Old documents and speeches are full of these symbolic uses.

In his camp at Onondaga lake, July 2, 1756, Sir William Johnson made a remarkable speech of this kind to the Indians assembled there. He had advised them to return the French hatchet and had sharpened their own by a belt. To this they had made a suitable response and waited his further pleasure. He said:

Brethren—two days ago you returned me thanks for sharpening your own Hatchet and said you had found mine last year at Oswego was not good. I told you then that I had some weapons

with me that were sharp likewise if properly made use of and I hope you will make use of them vigorously and our common enemy As your Hatchet is now sharp. I likewise sharpen your knife to cut our enemys throats or take their scalps off, and as I know it is an old custom amongst you to feast on your enemies flesh I present you those Kettles for that purpose. [This is meant figuratively, and some Meat is boiled in the Kettles, which they eat and call it French Mens Flesh, so when drink is given it is called blood of their enemies.]—*O'Callaghan*, 7:149

There was much profit in selling these implements. La Salle gave an account of trade at Fort Frontenac in 1684, with general demands, cost and profit. He wanted 1000 axes, which would cost 7 or 8 sous a pound and would sell for 30 sous apiece. They were prized as presents and Schuyler gave the Iroquois 300 hatchets in 1708. Metallic implements made blacksmiths necessary to the Indians and it became a matter of political importance whether the blacksmith was English or French. Old anvils have been found on village sites, the possession of which was matter for stratagem or debate two centuries ago. A few words on this may be of interest.

As the Iroquois increased their use of guns, axes and kettles, they more and more required the aid of smiths. The Mohawks could go to the white settlements, but this was too long a journey for the others. So, at a council in Albany in 1691, they renewed a previous request, saying: "We did formerly desire that we might have a Smith at Onnondage, whereupon a young Man that was a Smith by Trade, was sent us, and we gave him 20 Beavers for his encouragement to stay, but is gone away; again we request that we may have a Smith to mend our Arms, it being somewhat dangerous to come downe for every trifle hither, & we desire also that the Smiths here may in the meantime work as cheape as they did formerly."—*O'Callaghan*, 3:775

On behalf of all in 1692, Oheda, an Oneida chief, said, "We desire the blacksmith's Anvill that is at Onondage may remain there, and that there may be a Smith permitted to goe and live there for the mending of our arms, and not to goe away againe so soon as they have Traded, as the other Smith did."—*O'Callaghan*, 3:844

This may have produced but little effect, and, Feb. 25, 1693, the Onondaga speaker said to Gov. Fletcher: "Wee desire that yo^r Excellency would be pleased to ord^r a Smith to bee with us in o^r country to repair our armes that wee may defend ourselves against the French." Fletcher replied: "I doe grant yo^r request of a Smith, and will order one to live in yo^r country to repair yo^r armes."—*O'Callaghan*, 4:23

He was not so swift as his Indian name implied and they renewed their request July 4, 1693, with an addition. "Wee begge of you to lett us have a Smith & a gunn stock maker in our Castle to mend our armes when theyare broaken."—*O'Callaghan*, 4:43.

In 1700 the French offered to furnish smiths to mend their axes and guns. Some years later this led to a conflict of interests in the Iroquois capital, concerning which Father Jacques d'Heu wrote from Onondaga, May 24, 1708:

The English blacksmith has returned after nine months absence. On his arrival those of the French party were not willing to give him the anvil which belongs to them, and concealed it at my house and requested that a smith be sent from Montreal. That matter, I told them, would be discussed on M. de Joncaire's arrival. It seems to me that it would be very important for the good of religion and the French Colony, were there a French blacksmith here; the Englishman would then decamp. But this Blacksmith should be under the Black Gown and an exemplary man. One Donné would be our man, but I see no prospect of him. The anvil was given to the English blacksmith, because those of the English party were beginning to mutiny. But I'm told that if a Blacksmith came from Montreal he would get at once the anvil and all the tools belonging to those of the French party.—*O'Callaghan*, 9:816

There were afterward French smiths among the Senecas, but they did not remain long. It became a part of the New York policy to see that a reasonable number of its own blacksmiths were provided. Seldom have they been of such political importance.

In 1742 it cost £21 7½d to set up the bellows, anvil and vise at Cayuga, of which New York bore the cost. So it was proposed to the colonies of New York, Massachusetts and Connecticut, in

October 1747, "that a gunsmith be sent to each of the tribes following, viz: The Oneidas, Onondagas, Cayugas and Senecas, and two men with each gunsmith, to continue until next spring, and that goods valued at £360, New York currency, be sent with them."

In the laws of the colony of New York mention is frequently made of these blacksmiths. By order Cornelius Van Slyck jr and company resided in the Seneca country, Sep. 1, 1741, to Sep. 1, 1742, mending arms, etc. to prevent French plotting. About the same time Peter Lansing and Barent Staats jr were four months in the Cayuga country on the same business. In 1745 Garrit H. Veeder, the Cayuga blacksmith, was paid £60, with something for sundries. Ryer Booen went to Onondaga with goods, two men and a gunsmith, and was there from November 1747 to May 1748.

Hendrick Herkemer, gunsmith at Onondaga, with two helpers and materials, was paid £70 for services from October 1748 to May 1749. The Seneca blacksmith had the same. It was customary to spend about six months in this service. Others are mentioned but it will suffice to speak of William Printup, blacksmith at Onondaga in 1750. He was a favorite there for some years and his name is still borne at that place.

This matter receives special attention here because it has been customary to speak of the anvils and blacksmith's tools which have been found as French. Few or none of them were. The Onondaga anvil, which Father d'Heu said belonged to the French party, the Onondagas asked permission of the English to retain but a few years before. The latter had furnished it and a smith. In the Seneca country alone did French smiths work, as far as records go, and that but for a short time. It is probable one may have been with the French colony at Onondaga lake in 1756 but there is no clear proof of this.

The Iroquois were not willing their dependents should have equal advantages with them. In 1750 the Shawnees and Nanticokes wished a smith at Wyoming, as well as at Shamokin Pa. and sent their request by Cammerhoff and Zeisberger. The Onondagas positively refused this.

When we consider the great quantities of axes that the English and Dutch both sold and gave to the Iroquois, and the universal prevalence in early years of the form known as the French trade ax, we are led to believe that all were not French, but that this was the common European form two or three centuries ago, as it is in Germany yet. A large proportion, at least, seem to have been made at Utrecht. In any case most of the iron axes found on New York Indian sites passed through the hands of its colonists.

Fig. 8 is much reduced and has one unique feature. While having nearly the common outline, a sharp spike rises from the upper edge, 1¼ inches high, giving a height of 6½ inches to this corroded implement. It was found at Rome N. Y. and may be dated about the middle of the 18th century.

Fig. 99 is a large and typical trade ax from Pompey, unusually wide for its length. It has the frequent three crosses and is very heavy. The figure is much reduced, the implement being 8¼ inches long. This ax is in the Skaneateles library. Fig. 98 is a very large and peculiar ax, also much reduced, the actual length being 10⅜ inches. The lateral edges of the blade are now parallel, but the posterior may have been cut or ground down. The three crosses give weight to this supposition. In its present condition it is unique. It is in the Cazenovia library and was found at Nelson Flats, Madison co. as well as the following two.

Fig. 167 is the reduced form of a typical trade ax, with one unique feature. The two circles each inclose eight lines radiating from the center, instead of the cross. It is 7¼ inches long with a blade nearly 4 inches wide. Fig. 168 is similar but larger, the extreme length being 8¼ inches and the greatest width 4 inches. The three circles on each side each inclose a double cross. Both these show one characteristic feature of these early axes, the angular indentation of the outline below the socket. Quite a number have been found in the town of Nelson.

Fig. 90 is a curious ax in the Bigelow collection, which was found at Jack Reef on the Seneca river. It shows signs of long use, and was evidently once longer, but its most singular feature is a large rectangular perforation through the lower

part. The posterior portion inclosing the socket is like some modern forms. The iron is much corroded.

Fig. 116 is a reduced drawing of an iron ax belonging to the Johnstown historical society, and which was cast or forged in one piece. The slender iron handle was evidently intended to be inserted in one of wood. It is said to have been found 8 feet underground at Johnstown N. Y. and the general form is quite modern. The head is 3⅞ inches from top to bottom and the length through the handle is 9⅜ inches.

Fig. 89 is another of these solid forms, of what may be called a tomahawk pattern. It has a slender projection like the last, for insertion in a wooden handle, and a sharp spike once protruded in front. The upper part terminates in a long and curved point. It is quite thin, and was found at Fort Bull near Rome N. Y. The length was 10 inches and it now measures 8½ inches from the curved tip to the front angle of the cutting edge.

Fig. 102 is from the same place and of actual size. The cutting edge has been a little broken. This tomahawk is much like some of our present hatchets, but less angular. It is rather a frequent form. By degrees tomahawks took more slender, and even graceful shapes. Fig. 97 is a reduced representation of a very common kind. The maker's initials, J. G., are on both sides, and are shown in the drawing. Otherwise the surface is plain. This is owned by Wilson Johnson, on the Onondaga reservation and is 8½ inches long.

Fig. 101 is a slender tomahawk, as long above the handle as below. The upper part is much curved and sharply pointed. This is in the Bigelow collection and came from Jack Reef on the Seneca river. It is one of the most frequent forms and its extreme length is 8¼ inches.

Fig. 91 is a small iron tomahawk from Union Springs which approaches the pipe tomahawk form. Almost every variety of iron ax is represented there. Fig. 77 is a small iron hatchet from Fort Plain, and is quite unlike most others. It is in the Richmond collection.

Fig. 100 is a fine and slender steel tomahawk, with a pipe-bowl, which belongs to Mr George Slocum of East Onondaga. He had it from an old Indian who said it was used in the war of 1812.

Fig. 92 is from a half size drawing of a pipe tomahawk by Mr R. A. Grider. It is from the Bellinger farm, near Middleburg, Schoharie co. The handle is hollow and on it are 19 groups of three lines each which Mr Grider thought represented 19 scalps. They are quite as likely to have been purely ornamental.

Fig. 93 is a pipe tomahawk of unusual form, the handle of which is handsomely inlaid. The total length is 12¾ inches and the part represented is of actual size. It is said to have been given by an Indian woman to Mrs Thomas Dixon of Jamesville N. Y. about 1800.

Fig. 94 is a pewter tomahawk pipe found on Edward Black's farm, east of Onondaga lake and south of Liverpool N. Y. It has many moldings, and is slightly ornamented with dots. This would do very well for smoking and might have some slight value in war.

Fig. 95 is another tomahawk pipe from Stone Arabia, of the same material and neatly made. This is in the Richmond collection.

Fig. 88 is in the same cabinet, and came from Canada, but is no finer than many in New York. It is a brass pipe tomahawk, edged with steel and handsomely ornamented. Pipes of the same character may still be seen on the New York reservations, and many historical societies have good examples.

Fig. 96 is not so common and is much reduced here. It is a tomahawk pipe belonging to Cornelius Johnson of the Onondaga reservation. From the top of the bowl to the extreme point directly below is 10½ inches. Below the handle it has the form of a double-edged dagger, widest in the middle. The handle is adorned with brass nails and is finished with a brass knob in front.

Fig. 179 is a curious steel tomahawk in Mr William Lounsberry's collection at Tioga Center, but found on the north side

of the river. The peculiarity is in a sharp projection at the top and toward the handle. About Owego and along the Susquehanna above that point, iron axes and tomahawks frequently occur. Mr A. F. Barrott has one from Owego of the general trade form, but angular above instead of rounded, which is probably of a later type. Dr A. D. Gould has a pipe tomahawk from Willow Point, and others have been found.

Among the many tomahawks to be seen at Owego and vicinity is one belonging to Mr T. B. Reddish, which came from Middleburg, Schoharie co., where there were Indian forts and villages in the 18th century. This has a broad cutting edge, the implement being narrow at the socket and terminating in the long curved point above. On the expanded surface of the socket are the figures 1711. It is the only one reported with a date, except one from Pompey, dated in 1715.

Another Owego ax resembles the trade form, but has a neat scroll pattern indented in the sides. It is probably more recent than the form would indicate, though many pipe tomahawks do little more than add the pipe to this early form. In some of these, at least, the pipe bowl is formed separately and fixed by a screw.

Knives

It is surprising to see what delicate and beautiful work our aborigines did with their simple implements of bone and stone, but they were not slow to see the advantages of metallic tools and gave an appropriate name to their makers. A simple steel knife had a value to them of which we can faintly conceive. Fancy a white boy in the country without a knife! What wonderful things captives have been able to accomplish with one. It is almost the foundation of all civilized skill.

One early practice is commonly associated in our minds with the knife in the savage life of this land. It is that of scalping the dead. Fairly understood it has a different character from what many suppose, being the simple attestation or record of the warrior's prowess. It was not cruel, for no man intended to scalp the living. It was not intended as a savage mutilation, but to

secure proof of what had been actually done. It silenced the mere braggart, who had no scalps to show. Hideous as they seem to us, these were to the Indian what stars, crosses, and honorable medals are to the European soldier. Granting its savage features it was the plainest record in a savage state.

The white man changed this. The honorable distinction became a source of gain. A price was placed on scalps, and men and women were killed for money. Fame and distinction became of less value than mercenary returns, for the white man paid for scalps and beaver skins as kindred commodities. Of this the red man had not before thought.

The French paid scarcely $6 for men's scalps, but King Louis thought they must economize in this. In 1694 he wrote to Frontenac and Champigny, then in Canada, that "His Majesty desires that they conform themselves to the order he gave them last year, to cease paying the Christian Indians 10 silver écus for every Indian killed, 20 écus for each prisoner, and half these sums for women; this will be a further diminution of the estimate. This expense can not be afforded."—*O'Callaghan*, 9:573

The New York colonists acted independently and more liberally or else, the general price had advanced in half a century. Under date of May 7, 1747, Col. Johnson wrote to Gov. Clinton: "We shall soon have abundance of prisoners and scalps, wherefore will require a great deal of money, which they expect will be ready here at their return. I have paid the first who came home £60 for the six scalps brought from Crown Point which I could not avoid, and when the rest come in I must do the same, for they look to none else for it & must have it, as they say, punctually paid according to promise."—*O'Callaghan*, 6:361

Many quotations might be made illustrating this subject. Whether bounties were paid by either side during the revolutionary war does not clearly appear, though it is probable. The noted account of scalps taken by the Senecas, published in 1782, was long believed but is now known to have been written by Dr Franklin for political purposes. It has yet a certain value as being a good description of how scalps were stretched, dried and painted.

One of the great medicines of the Iroquois is connected with a traditional scalping incident and a great Huron feast was founded on the same story. The owl and the wolf meet, and the coming of the Ontarraoura is predicted. This animal seems to be the panther, or mountain lion, and to him the resuscitation of the good hunter is ascribed. In the New York story the good hunter loses his life and scalp. After many trials a bird brings the scalp back, but it is so dry it will not fit. At last the eagle suggests softening it with the mountain dew which has collected between its shoulders. The scalp becomes pliable, is fitted to its place, and the good hunter lives again, to the great joy of bird and beast. In this the presence or absence of the scalp becomes synonymous with life and death.—*Beauchamp*

In general there is nothing to distinguish the scalping from the hunting knife, but nearly all are pointed. Some were supplied ready for use; in other cases the handling seems to have been left to the sons of the forest. They were sold or given as presents by Dutch, English and French, and were of many forms and sizes. Illustrations will be given of a few of these but from their thinness most have perished.

The Dutch so soon began a spirited Indian trade that the French could do little in New York, except among the Senecas. Knives were among the smaller articles which La Salle wanted at Fort Frontenac in 1684, but in 1708 M. de Longueuil reported that Schuyler had given the Iroquois 800 knives. At the siege of Detroit in 1712 the French Indians were given 190 butcher knives, to be used as bayonets. These may have been the long carving knives here shown.

Among the presents to the Iroquois at Albany July 3, 1693, were 87 hatchets and four gross of knives; and among those recommended the next year were "2. Grose of Knives black hafted sharpe points." They were an ordinary article of trade besides. Hence we may conclude that most of those found in New York were of Dutch or English make. During the period of the French missions here, French articles were quite freely used, but before and after the supply was small. This is not

quite in accordance with prevalent opinion, but the proof is clear. West of Onondaga the French for awhile had a better chance. The question is one of interest but can be treated better in speaking of ornaments.

Fig. 106 was found in the town of Venice N. Y. in September 1887. It has a well preserved bone handle of European make and the total length is 8½ inches. All the illustrations on this plate are reduced. Fig. 107 is quite like the last, but the bone handle is differently ornamented. It is in fine condition and was found at Scipioville in 1886. It is a trifle longer than the last, the point having been less ground. Fig. 109 is from Fleming in the same county and has a horn handle, possibly of Indian make. The form differs from the last two, and it saw more use. The full length is 9 inches.

Fig. 110 is an iron knife in the Vail collection, found in the fort south of Pompey Center, with several others. This is a relic of the early Dutch trade, no distinctly French articles being found on this site. The handle is gone but the usual tang for hafting remains. The full length is 6¾ inches. Fig. 112 is from the same place, differing only in length, which is 9 inches.

Fig. 122 is a much corroded knife from Pompey, belonging to the writer. It is wider than usual. Fig. 105 was found at East Cayuga in 1888 and is more suggestive of a typical scalping knife than most others. The rude handle is of horn, probably made by the Indian owner. Fig. 118 is much reduced. This knife is said to have been used in war, and was given to Albert Cusick by another old Onondaga Indian. The blade is sharp, slender and curved, and the wooden handle well preserved. The full length is 15 inches.

Fig. 114 is almost unique, but there is another smaller one like it from an adjoining site. Both are from Fleming and were found in 1887. In this one but a small part of the iron blade remains. The handle is of brass and shows two Flemish lovers in an affectionate attitude.

Two very remarkable French knives are drawn from photographs furnished by Mr W. W. Henderson of Jamestown N. Y. In the illustrations they are much reduced from the full size. Under date of July 1, 1887, Mr Henderson wrote:

The knives were found in gravel, below the base of an artificial mound erected on a high ridge, through which a roadway had been cut, removing half the mound, and leaving the roadbed 10 feet below the base of mound, as first discovered by early settlers. In excavating for the roadway the knives and bones no doubt slid down from a point above in the body of the mound. The apex of the mound is at present 15 feet or more above the roadbed. It is thought De Celeron with his large company of French and Indians camped near this spot in 1749, and long previous to this date the natives of this locality no doubt had intercourse and traffic with the French in Canada. . . The above mentioned mound is near Jamestown and the knives were taken from it April 1887. They bear the words "Lempier—Rue St Honore—34. a Paris."

In a letter dated May 10, 1901, Mr Henderson corrected this statement:

Two steel French knives, 12 inches in length of blade, one 2 inches in width at the handle and the other 1½ inches, bearing the trademark "Sabatier, Rue St Honore, 84, A Paris," were found with a human skeleton in removing a large mound from highway near Fluvanna. They were doubtless obtained by the Senecas from the French in Canada by traffic or stealth, or were intrusively buried in this mound with some deceased French hunter.

Fig. 169 shows the narrowest of these knives, the trademark being on the opposite side. It is 1½ inches wide at the handle and 12 inches in length thence to the point. Fig. 170 is 2 inches wide at the handle with a blade 11 inches long. They are like the common carving knife and suggest the butcher knives to be used as bayonets.

Fig. 72 is a large, flat and angular knife, made from a brass kettle, and found near Beaver lake, Lysander. Grooves and notches have been filed near the base, for secure attachment to the handle. Iron knives were so abundant that a makeshift like this is rare.

Fig. 178 is a remarkable recent copper knife of moderate thickness, found by Mr Luke Fitch on Indian hill, Pompey. The form is that of a shoemaker's knife, and it has a tang for insertion. Iron knives are frequent there but this is the only copper one the writer has seen.

Miscellaneous

Prefatory to an account of a few miscellaneous metallic objects found on Indian sites, it may be well to mention some of those of all kinds on which duties were imposed in New York in 1686, and which were intended for Indian trade. Most of these have the word "Indian" prefixed.

They were Indian duffels, strouds, blankets, plain cottons, half thicks, white Olembriggs, kettles, hatchets, hoes, red lead, vermilion, cotton, red kerseys, knives, shirts, shot, woolen stockings, Indian haberdashery, drawing knives, looking-glasses, wooden combs, beads, tobacco in roll, belts, scissors, jew's-harps, Indian paints, drills, tobacco boxes, Tinsie lace, gimp lace, needles, tobacco tongs, powder horns, Indian heales (steels). In the law of 1692 white osend cloth takes the place of white Olembriggs, and in that of 1699 it reads white Ozenbrugs Mellish. Both have bells instead of belts, and this is probably correct. Guns with all their parts afterward appeared among treaty presents, adzes, shears and toys, powder and ball, bars of lead, gun flints, shoes with and without buckles, hats, fans, articles of shell, laced coats and hats, red coats, jackknives, garters, tomahawks in 1714, silver medals, added to a large trade in ornaments of silver and brass.

Peter Stuyvesant wrote to the duke of York on behalf of the Dutch inhabitants, in 1667, in regard to this trade:

Since the Trade of Beaver, (the most desirable comodity for Europe) hath allwayes been purchased from the Indyans, by the Comodities brought from Holland as Camper, Duffles, Hatchetts, and other Iron worke made at Utrick &c much esteemed of by the Natives, It is to be fear'd that if those Comodities should fail them, the very Trade itself would fall, and that the ffrench of Canida, who are now incroach'd to be too neare Neighbours unto us (as but halfe a days journey from the Mohawkes) making use of their Necessities and supplying them, they will in time totally divert the Beaver Trade, and then the miserable consequences that will ensue, wee shall not have one shipp from Europe to trade with us.—*O'Callaghan,* 3:164

On this general question of use and supply the liberty is taken of quoting part of a letter from Mr S. L. Frey on recent articles

found in the Mohawk valley. Some of it may be irrelevant, but no more appropriate place may be found for it:

In the modern sites there is found a great variety of traders' iron and copper work. I have some; principally iron axes, hoes, padlocks, jew's harps, thimbles, knives—some made from files, cold chisels, steels, etc. Copper kettles are found in graves, as well as ornaments of copper. I have but a few. Venetian beads are in great variety. Nails, buckles, and horse shoes are found; also hinges, gun locks and barrels. Every digger has some novelty. Most of the iron axes found here, marked with one, two and three crosses, were made at Utrecht for the Indian trade. The white clay pipes marked R. T., E. B., and others, are English, while some others are Dutch. They were given to the Indians by thousands. Grès de Flanders ware was brought in small quantities by the traders. I have one jug from a grave, and I know of one other with the arms of the city of Amsterdam on it. There is a curious white earthen vessel in the Richmond collection, from a grave, and I have heard of a few other pieces of earthenware. Bottles are singularly scarce. I know of one "apostle spoon." I never heard of a single steel trap being found. English gun flints are not uncommon. A rum bottle with W. J. impressed (said by the finder to mean William Johnson) came from the site of the Jogues shrine.

The writer again calls attention to the fact that the so called French axes were most of them made in the Netherlands. It is quite the fashion in the interior of New York to call any early European remains French and there are several nominal French forts where none ever stood. Articles of a religious character mostly came from that nation.

Steel traps were commonly used at a distance from the towns and were not likely to be lost at home. The writer has found but one small one on an Indian site. This may be recent, but seems antique. Bottles are rare and may have been little used. The Indian did not drink while hunting, but emptied the keg at village feasts. Cups were used then, and several silver ones have been found.

The above summary does not include everything furnished in the Indian trade, but no one who reads it will be surprised to find any article of the period on any Indian site later than the middle of the 17th century. It was a simple question of

use, taste and ready supply. No durable article mentioned above has failed to appear in one place or another while the list might be much extended. The Indians used compasses for laying out geometric figures, and the writer has seen a hammer stone, with circles and an inscribed star, which was found in an Indian fireplace. Thimbles, locks and keys, bars of lead, buckles, sword hilts, large and small vises, pewter platters, spikes, trammel hooks, handsaws, anvils, cannon balls, horseshoes, hammers, files, hoes, steels for striking fire, are among the articles found. Mr J. V. H. Clark says of the northern part of Pompey: "Wagon loads of old iron have been taken from these grounds."

Fig. 108 is a fine and curious steel chisel from Pompey which was in the Ledyard collection. The edge is good and there are two long and deep grooves above this, one above the other, reaching about half way of the long and slender implement. The edges are chamfered near the base.

Fig. 76 may be called an iron chisel. It is quite broad for its length, which is 4½ inches including the broad tang. It was found in Fleming in 1887 and is much corroded.

Fig. 126 is a quadrangular steel celt, found on lot 53, southeast of Pompey Center. All other remains known to the writer there are prehistoric, but the fort of 1640 is about a mile west of where this was found. It is a fine and unusual article.

Fig. 124 is an iron awl from the fort just mentioned. It is corroded, but sharp and somewhat curved. Fig. 125, from the same place, is much like the last, but smaller. Some of the old Onondagas yet have similar ones in bone handles. Fig. 154 is from the same place, and is of the same general character. They are frequent there.

Fig. 81 is in the Hildburgh collection and came from Ontario county. It is long, flat and sharp, and might be called an awl, but Mr Hildburgh considers it a brass arrow or spear head. In either case it is an unusual form.

Fig. 161 is a slender, flat and curved copper awl from Indian hill, Pompey, where many have been found. It has the appearance of being cast.

Fig. 123 is an iron spike found by Seneca river, in Lysander. It is cylindric, long and slender, with a narrow base, and is not a rare form.

Fig. 64 is a long iron spear, greatly reduced in the illustration, the full length being 8½ inches. This was found in the town of Oakfield, and belongs to C. F. Moseley, of Bergen N. Y. The triangular base has a triangular perforation, and the other end forms a spearhead, occupying two fifths of the entire length.

Fig. 119 is a spearhead at the end of a very long shank. It is of iron and was found 2 miles west of Canajoharie. Fig. 121 has the same general form but the shank is but about half the length of the last. This was found at Indian Castle north of Watervale. The form is frequent and widespread.

Fig. 115 is an iron spearhead, much like a double bladed knife or dagger. It is leaf-shaped and has a tang. This is from the fort south of Pompey Center, where several have been found. It seems much rarer elsewhere. Fig. 120 is much like the last, but the blade is less than half the entire length. It was found in 1885 at Cross lake.

Fig. 185 is a cylindric piece of copper, hammered down to a broad edge at one end. This is from Indian hill, Pompey.

Fig. 69 is an old steel for striking fire with flint and tinder, which belongs to William Isaacs of the Onondaga reservation. This was the national emblem of the Mohawks and rude drawings of it may sometimes be seen attached to old treaties. The Mohawks probably got the flint and steel soon after coming to New York, if not while still in Canada. Their own name referred to this as far back as it can be traced, and they came in contact with the whites first of all the Iroquois. The early Norsemen used the same form of steel. Many forms occur.

Fragments of brass kettles were utilized for tools and ornaments. Fig. 18 shows such a fragment notched for a saw. Fig. 135 is a much larger piece, one edge of which is merely regularly cleft with a knife for the same purpose. It was found by the writer on the recent site near Wagner's hollow, in Montgomery county.

Fig. 165 is a slender copper fishhook from the recent site known as Upper Cayuga, on lot 114, Ledyard. There were many of these there and at Scipioville. Fig. 166 is a large iron fishhook from Scipioville, where several were found. This one has the line still wound around the shank, where it was preserved by iron rust.

Fig. 162 is a pewter mug from a grave at East Cayuga site, lot 95, Fleming. In the mug were 44 French coins, dated from 1642 to 1656, and mostly having two holes for suspension. All were of copper, about the size of our half cents but thinner. This mug was found by and still belongs to Mr John Perkins.

Fig. 15 is a bullet as it came from the mold, found at Indian Castle, north of Watervale. Musket balls often occur in good condition, ready for use but unfinished. The writer has figured bullet molds from the same place.

Two immense iron hoes were found at Fort Bull near Rome N. Y. One of them was 7¾ inches broad by 7 inches deep with an ample socket for the wooden handle. On the Cattaraugus reservation may still be seen similar great hoes which the Senecas say were presents from Washington.

Tobacco boxes were commonly changed into paint boxes and receptacles for ornaments. One of these, filled with trinkets, was found in a grave 2½ miles west of Fort Plain. They often occur in graves, placed there when it was the fashion to inter articles with the dead. This one was nearly 3 inches across.

Mr W. W. Adams took out of one Cayuga grave the following articles, May 2, 1888: One brass kettle, 17 flints, two gunflints, six bullets, six long shell beads, a bone harpoon, three buckhorn handles, a knife with buckhorn handle, 21 gaming flints, three bars of lead, five rubbing stones, 16 bears tusks, two axes, two pairs of shears, four pairs of bullet molds, two gunlocks with flints, 47 pieces of gunlocks, 32 knives and cutting implements, two large iron shears, a gun 4 feet 8 inches long, a pipe, a piece of black paint, a piece of mica, two trigger guards, one wormer, a gun cleaner, steel and two flints, a quantity of

powder in a cloth bag, two melting ladles and 2500 wampum beads. There were also some Jesuit bronze rings.

Though this is a great quantity from one grave, attesting the dignity or wealth of the inmate, some others probably exceeded this in value when silver ornaments lavishly adorned the dead. Nothing was too good if they were really loved. The above list is curious in showing the contemporaneous use of many things.

In describing the foregoing articles the writer has not forgotten that only those of native copper can be strictly called aboriginal, but the later ones illustrated or mentioned were used by men still in their savage state, and in their own wild way. They were features of Indian life here for two centuries, and to understand that life we must know something of what was in daily use. It has been deemed sufficient to merely mention many things. Guns and all that appertain to them have been omitted. Jew's-harps needed no illustration, unless of a plumed and painted warrior playing on one. Thus many things are omitted in the figures given as being well known in a general way, while prominence has been given to others of prehistoric age. Nearly half the figures are of native copper articles and references are made to very many more. By far the larger part of these have been found east of Cayuga lake, and north of the southern watershed of the Mohawk valley. West of the Genesee river and in the southeast part of the state few have been reported. This may be the result of several causes now left without discussion.

The subject of metallic ornaments is left for another paper, though incidental reference has been made to them in this. They were very few in this state in prehistoric times, for readier and more showy materials were found. Copper implements were more in demand, for their toughness and durability recommended them, even when stone could be more easily wrought. They reveal trade and travel, and a skill of no mean order in working with primitive tools.

EXPLANATION OF PLATES

Page numbers refer to fuller descriptions in bulletin.

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(All reduced)

Plate 2

(All reduced)

Plate 3

Plate 4

Plate 5

Plate 6

Plate 11

Plate 12

Plate 13

Plate 14

Plate 15

Plate 16

Plate 17

Plate 18

Plate 19

Plate 26

(All reduced)

Plate 27

Plate 28

Plate 29

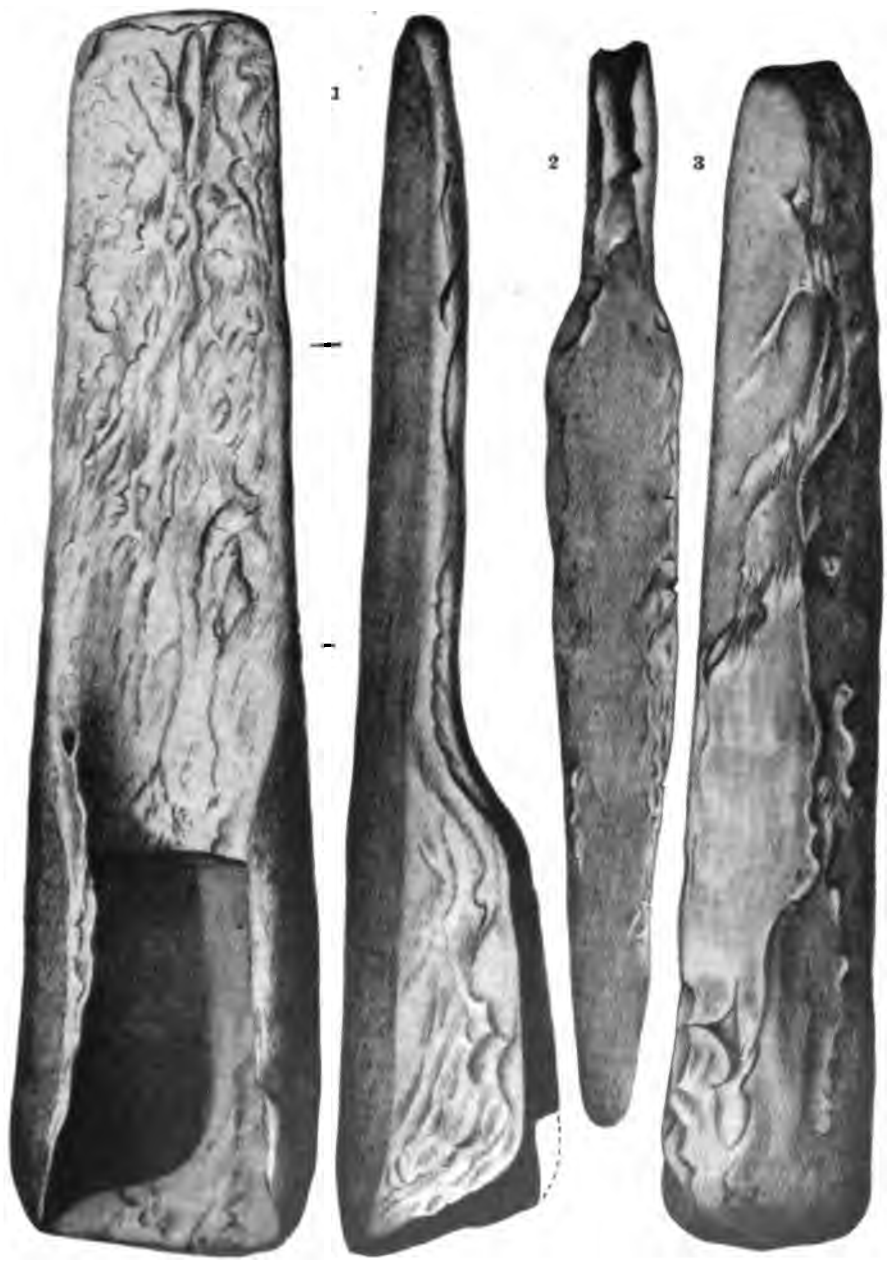
Plate 30

Plate 31

Plate 32

Plate 33

Plate 1



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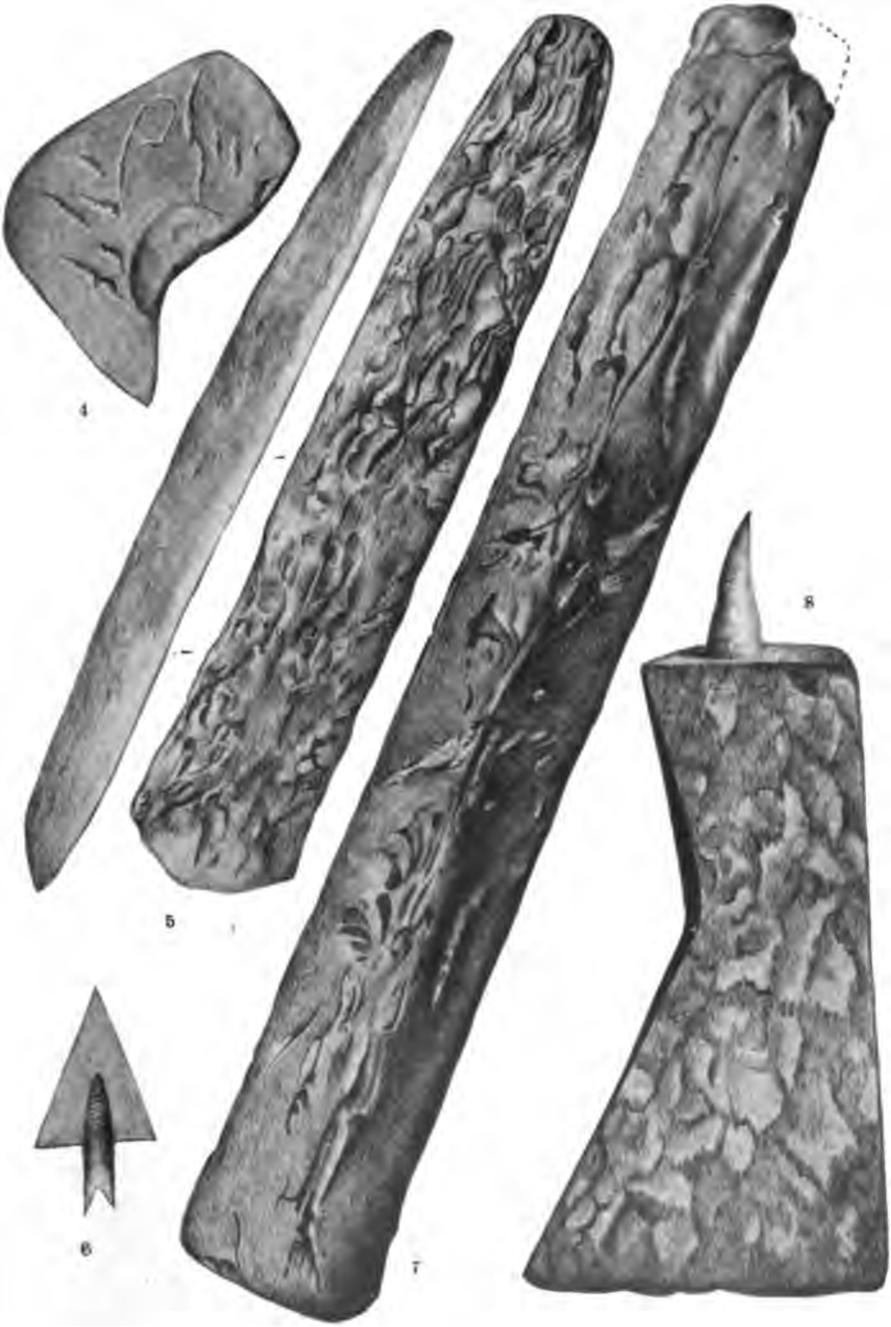

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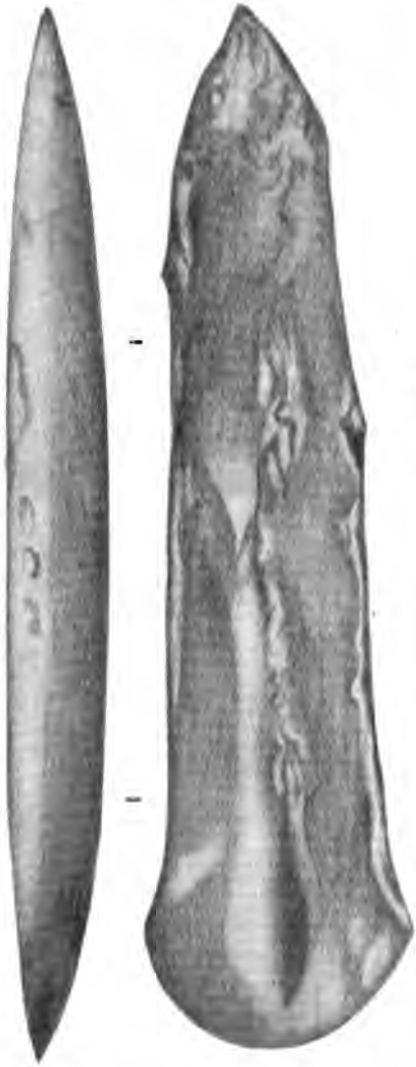

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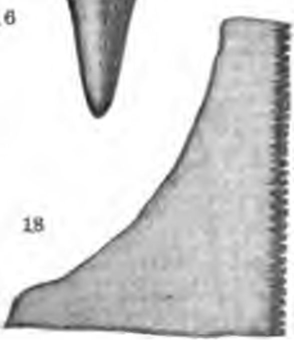

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Plate 6

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Plate 7

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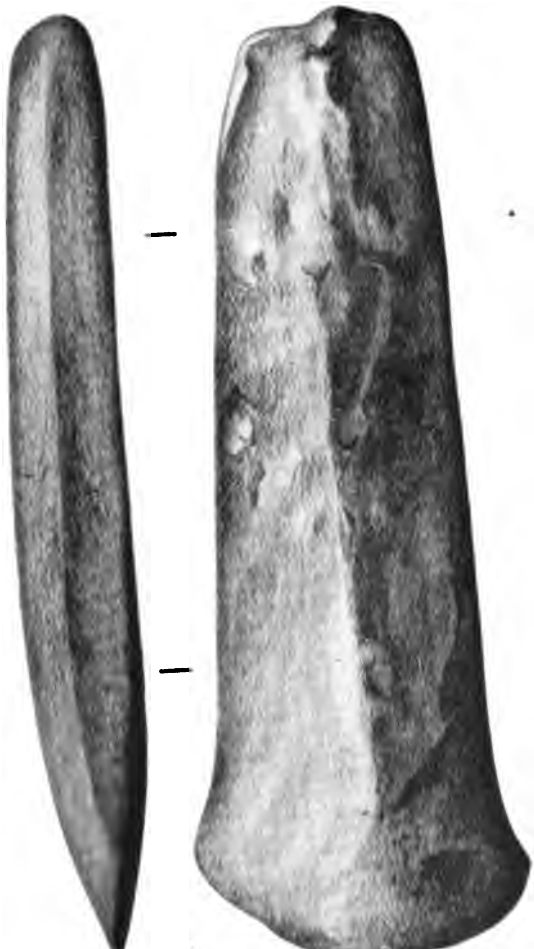
Plate 8



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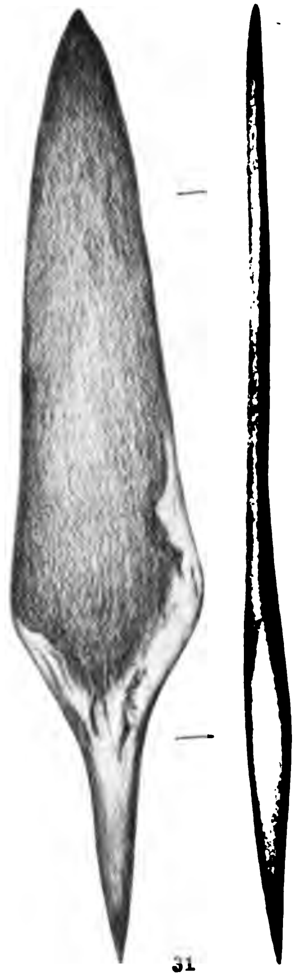

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Plate 10

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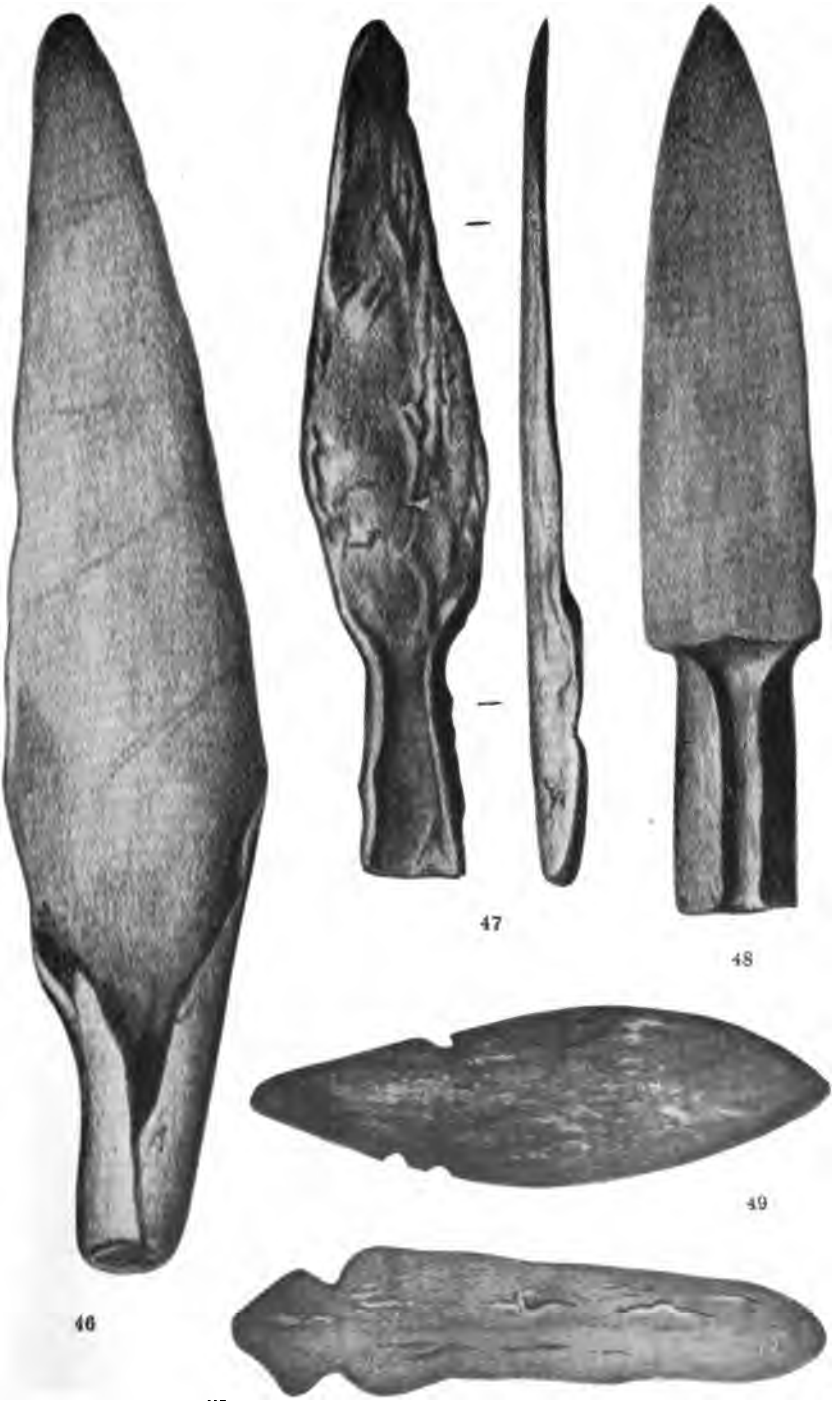
Plate 12



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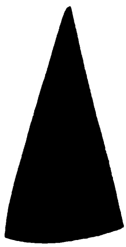

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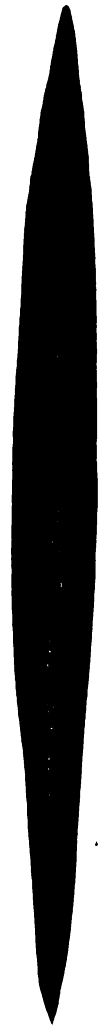

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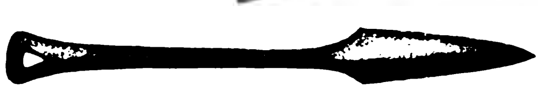

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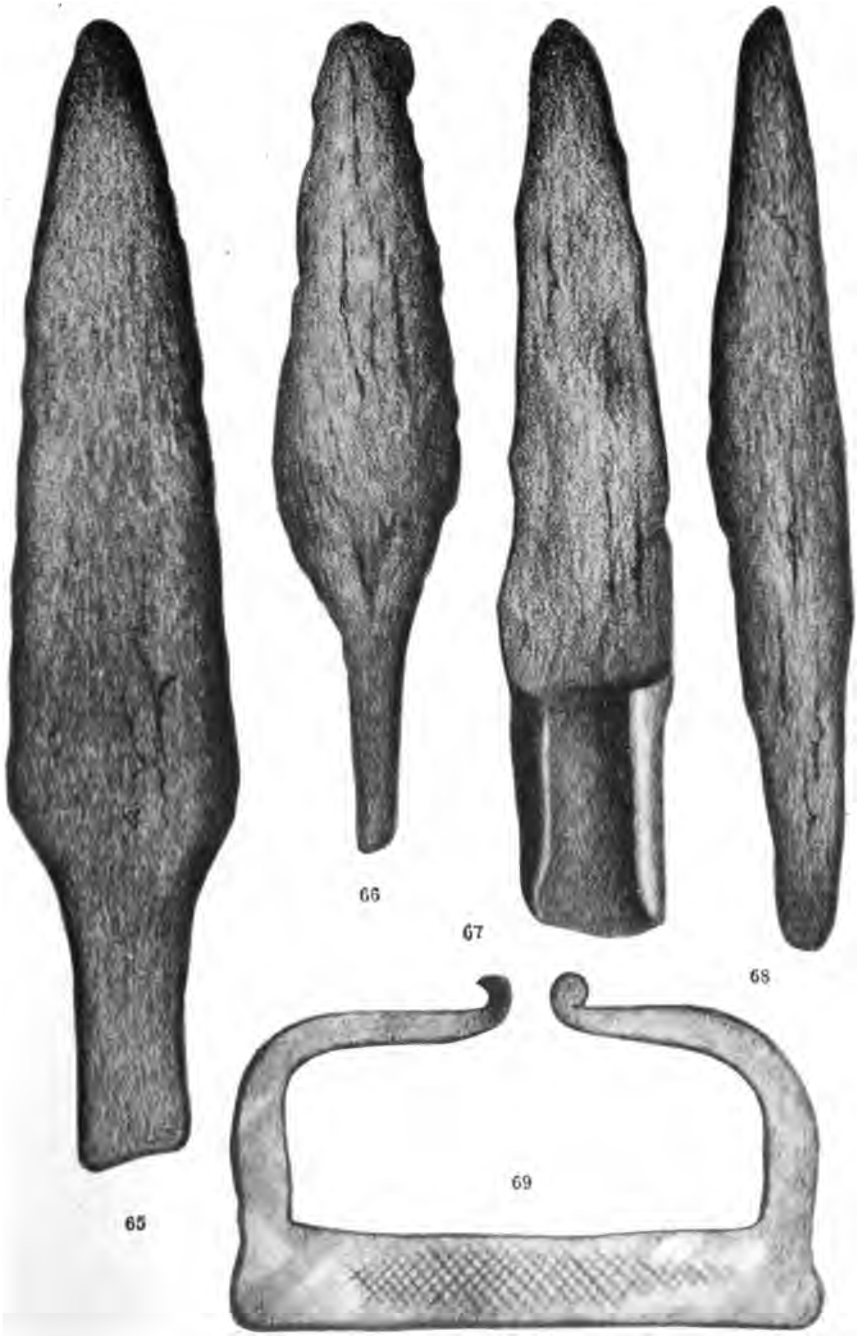

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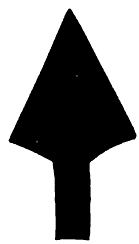

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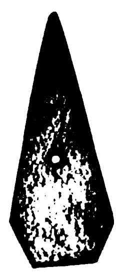

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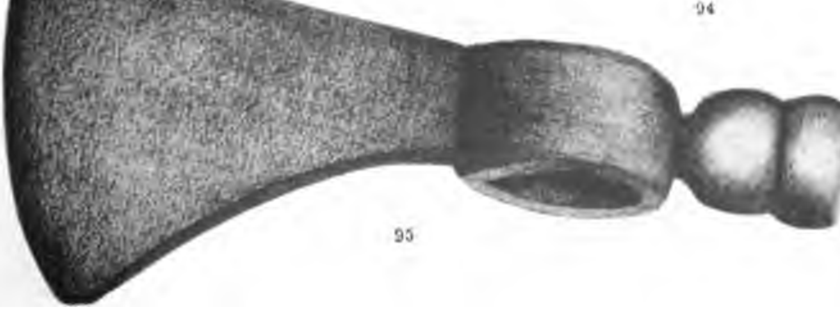

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Plate 23

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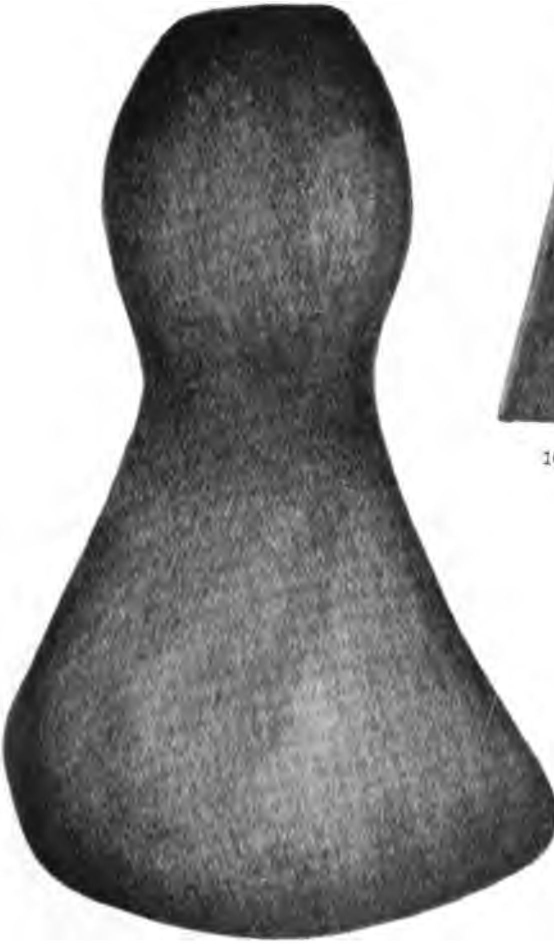
Plate 25



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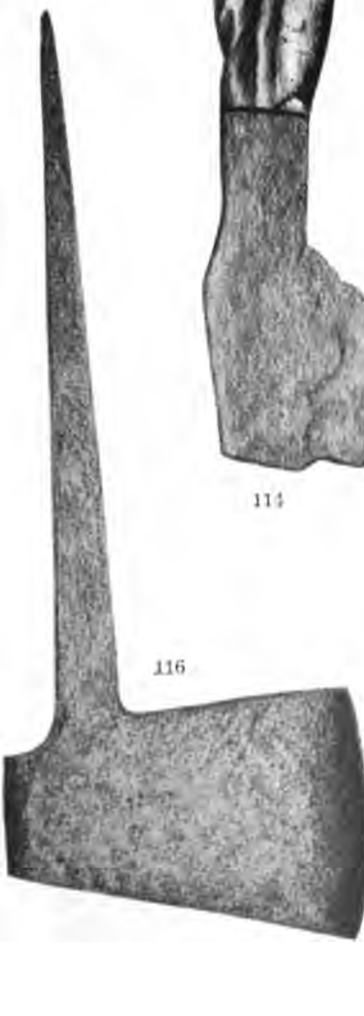

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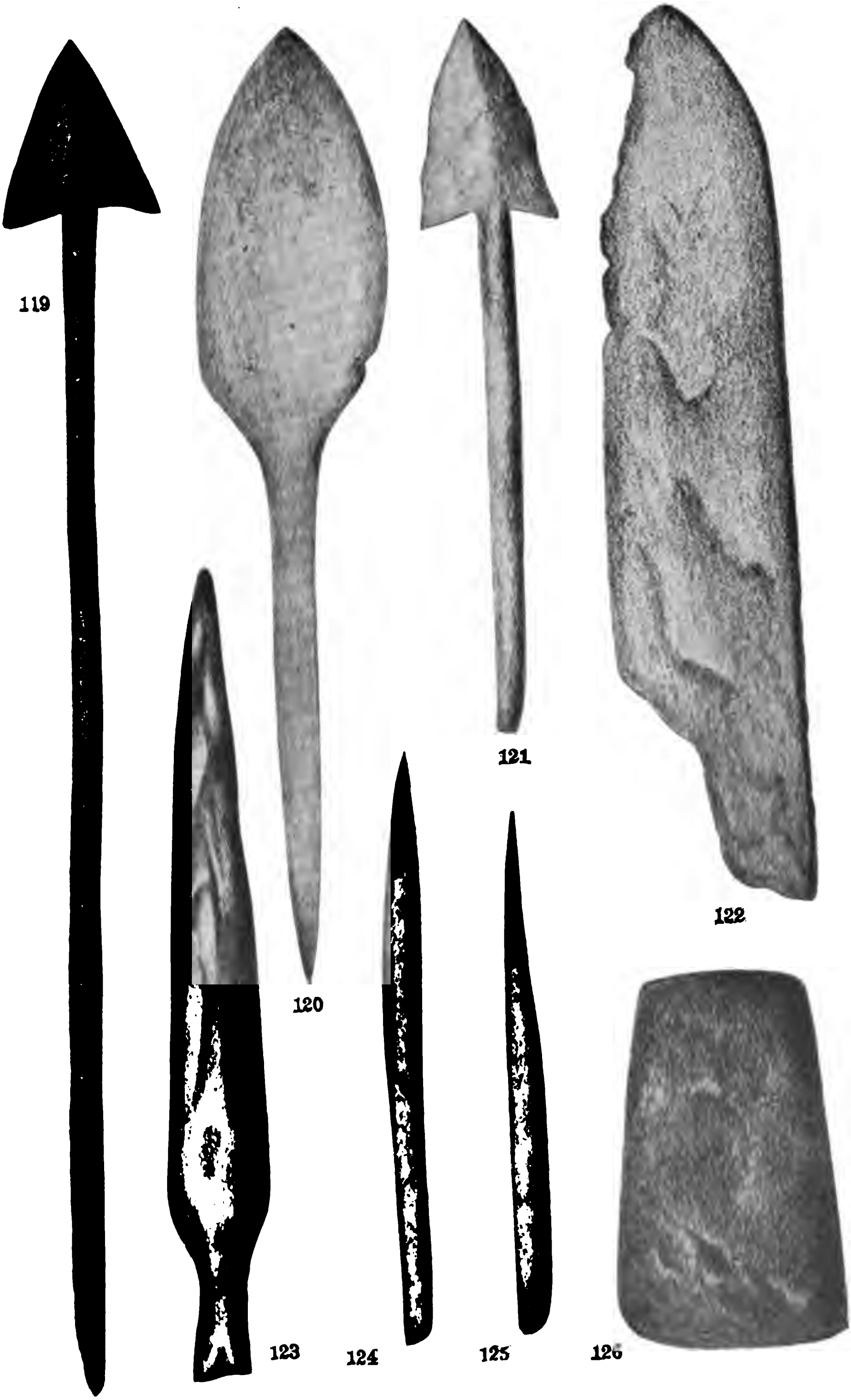

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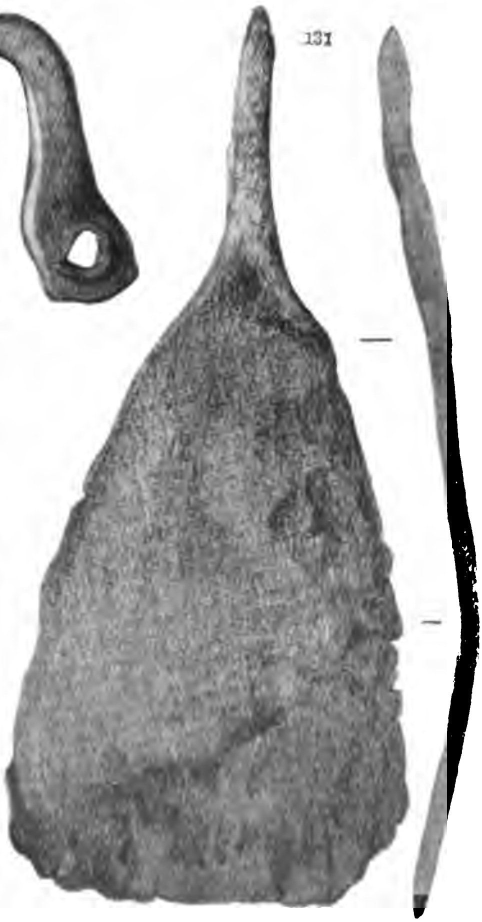

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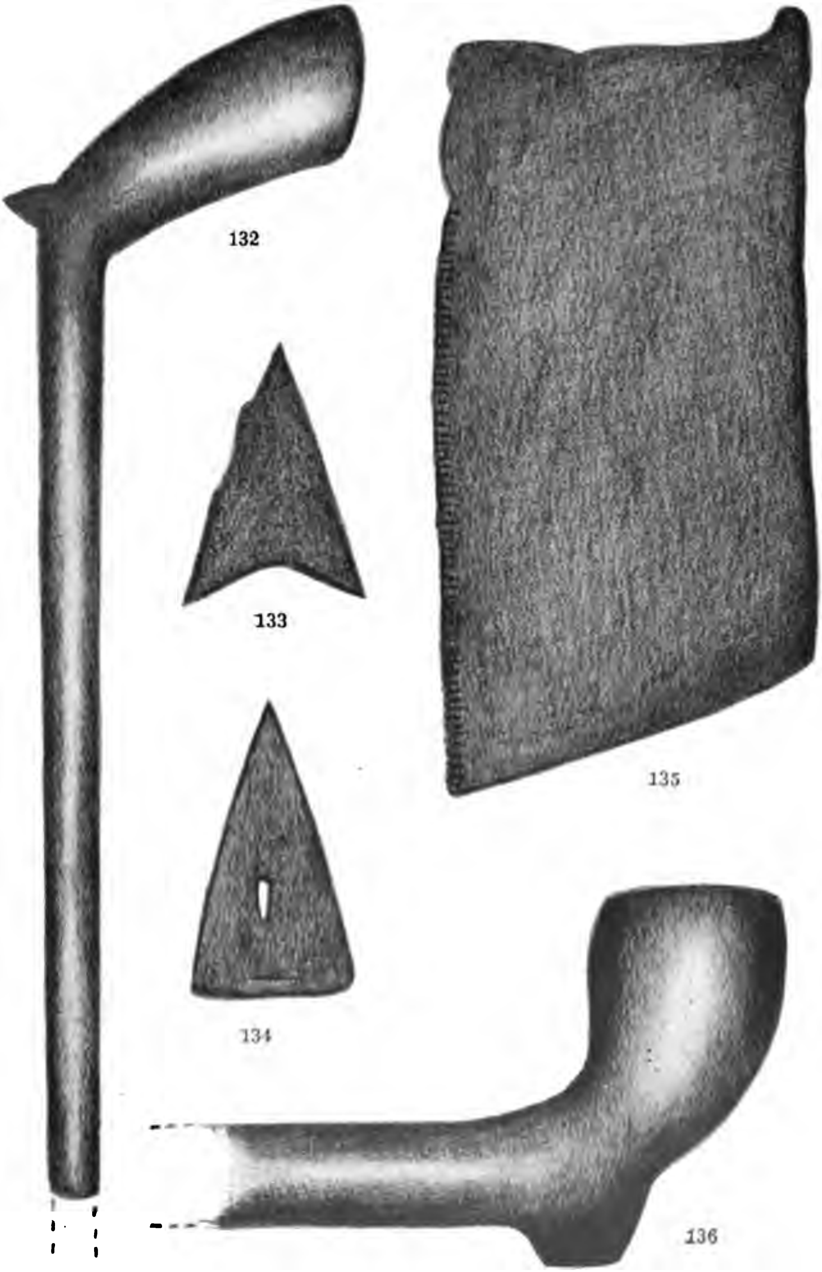

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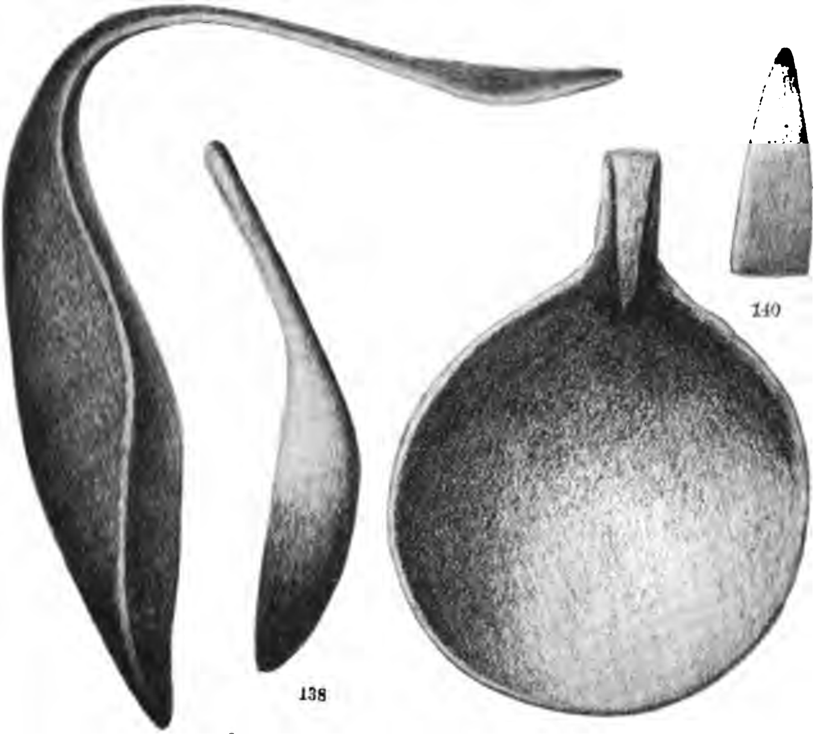

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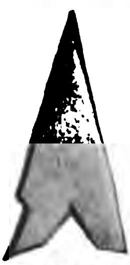

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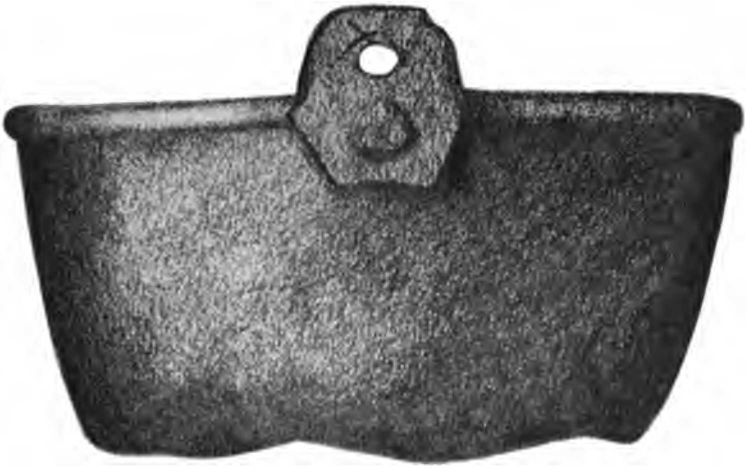

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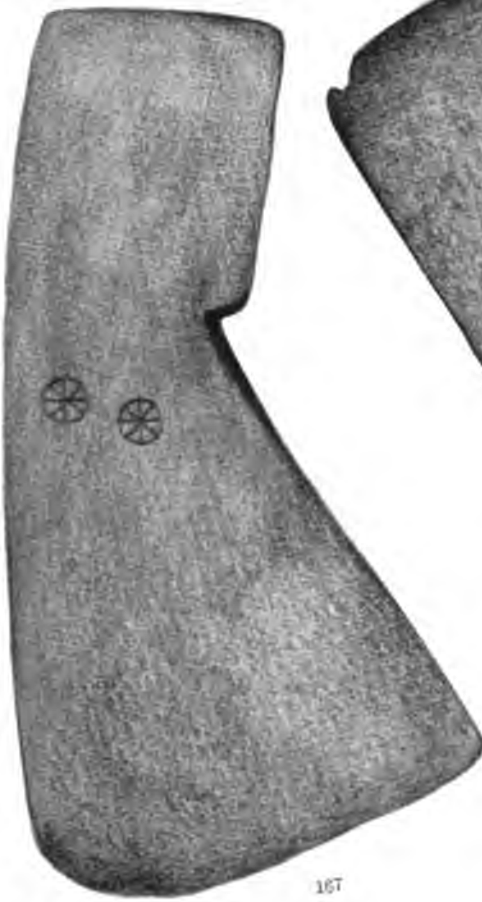

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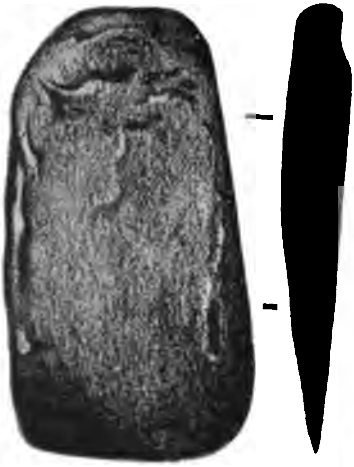

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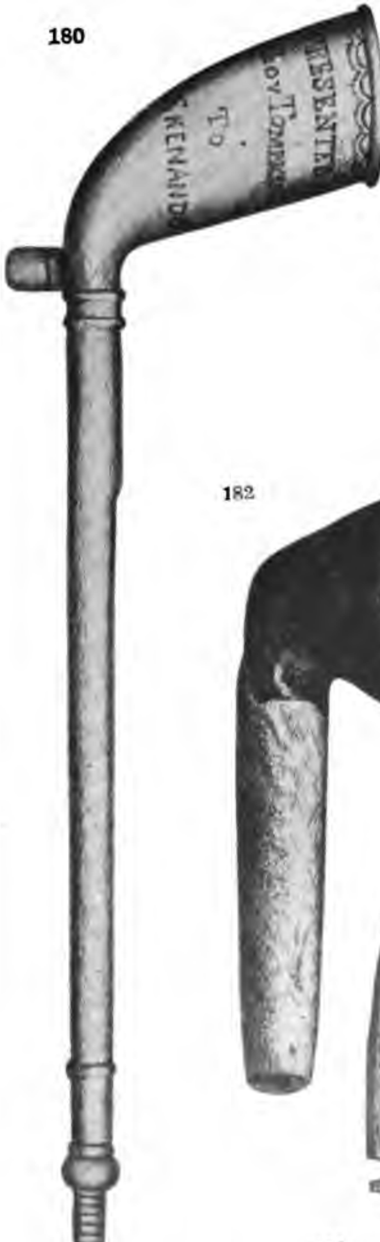

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University of the State of New York

New York State Museum

MUSEUM PUBLICATIONS

Any of the University publications will be sold in lots of 10 or more at 20% discount. When sale copies are exhausted, the price for the few reserve copies is advanced to that charged by secondhand booksellers to limit their distribution to cases of special need. Such prices are inclosed in brackets.

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12 (1892)	$.50	16	$1	19	$.40
14	.75	17	.75	20	.50
15	1	18	.75		

In 1898 the paleontologic work of the state was made distinct from the geologic and will hereafter be reported separately.

Paleontologist's annual reports 1899–date.

See fourth note under Geologist's annual reports.

Bound also with museum reports of which they form a part. Reports for 1899 and 1900 may be had for 20c each. Beginning with 1901 these reports will be issued as bulletins.

Botanist's annual reports 1869–date.

Bound also with museum reports 22–date of which they form a part; the first botanist's report appeared in the 22d museum report and is numbered 22.

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Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have been published in volumes 1 and 3 of the 48th museum report and in volume 1 of the 49th, 51st and 52d reports. The botanical part of the 51st is available also in separate form. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged, and combined with others more recently prepared and constitute Museum memoir 4.

Entomologist's annual reports on the injurious and other insects of the State of New York 1882–date.

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5	.25	10	.35	15 (" 31)	.15
6	.15	11	.25	16 (" 36)	.25
7	.20	12	.25	17 (" 53)	*In press*

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Bulletins are also found with the annual reports of the museum as follows:

Bulletins	*Report*	*Bulletins*	*Report*	*Bulletins*	*Report*
12–15	48, v. 1	20–25	52, v. 1	35–36	54, v. 2
16–17	50 "	26–31	53 "	37–44	" v. 3
18–19	51 "	32–34	54 "	45–48	" v. 4

The letter and figure in parenthesis after the bulletin number indicate the division and series number. G=geology, EG=economic geology, Z=general zoology, A=archeology, M=mineralogy, P=paleontology, B=botany, E=entomology, Misc=miscellaneous.

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Printed also with Museum bulletin 15 and the 48th museum report, v. 1.

—— Geologic Map of New York. 1901. Scale 5 miles to 1 inch. *In atlas form $3; mounted on rollers $5. Lower Hudson sheet 60c.*

The lower Hudson sheet, geologically colored, comprises Rockland, Orange, Dutchess, Putnam, Westchester, New York, Richmond, Kings, Queens and Nassau counties, and parts of Sullivan, Ulster and Suffolk counties; also northeastern New Jersey and part of western Connecticut.

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BULLETIN 273 NOVEMBER 1902

New York State Museum

FREDERICK J. H. MERRILL Director

Bulletin 56

GEOLOGY 5

DESCRIPTION OF THE

STATE GEOLOGIC MAP OF 1901

BY

FREDERICK J. H. MERRILL Ph.D.

ALBANY

UNIVERSITY OF THE STATE OF NEW YORK

1902

Price 10 cents

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New York State Museum

FREDERICK J. H. MERRILL Director

Bulletin 56

GEOLOGY 5

DESCRIPTION OF THE

STATE GEOLOGIC MAP OF 1901

PREFACE

The purpose of this bulletin is to give a certain amount of information which could not be expressed on the geologic map of 1901, namely the detailed credit for the material used in its compilation.

With this it has seemed worth while to give some items of general information about the history of geologic work in New York. The matter relating to the early Natural History Survey is in part based on an article by the late Dr James Hall in a publication entitled *Public Service in the State of New York,* which has been copiously quoted because of its convenient form, though the facts given are on record elsewhere.

In compiling a second edition of the geologic map of the State of New York, on the scale of 5 miles to the inch, the writer has found the task exceedingly complex. While the geology of New York has been carefully studied by many competent observers the lack of accurate maps has rendered much of the field work unavailable for graphic reproduction because many accurate observations could not be located. It also appears that in the earlier work the geologists have not understood the most practical methods of locating their observations, the practice seemingly having been to locate outcrops with reference to drainage rather than with reference to roads.

From the earliest times roads have been surveyed and their principal turns and angles have been located with sufficient accuracy to make them available for reference from one map to another. On the other hand, as the streams have rarely been surveyed and their meanderings have been represented in a conventional and conjectural manner, outcrops or boundaries referred to them are usually unavailable for plotting on an accurate base.

In offering the present map and its accompanying bulletin to the public, the author does not expect that he has been able to avoid errors and he earnestly asks the cooperation of all who are interested in the geologic map of New York to aid him in making it as accurate as possible by supplying corrections for a revised edition.

FREDERICK J. H. MERRILL

Albany N. Y. July 1902

The geologic map of New York, edition of 1901, is sold in atlas form for $3. Mounted on rollers $5.

INTRODUCTION

The geologic map of New York is a graphic expression of the general results of the geologic study of the rocks of the state. This study began as early as 1820 and has been carried on continuously, not only under state auspices, but by private and federal enterprise, and many valuable contributions have been made by geologists not in the state service.

A very complete bibliography of articles on New York geology will be found in bulletins of the United States Geological Survey, nos. 127, 130, 135, 146, 149, 156, 162 and 172.

HISTORY OF THE NEW YORK GEOLOGIC SURVEYS

In 1820 and 1821 Prof. Eaton, with the assistance of Drs T. Romeyn and Lewis C. Beck, under the patronage of Hon. Stephen Van Rensselaer, conducted an agricultural and geological survey of Rensselaer and Albany counties. These surveys, of which reports were published, were intended to serve the interests of agriculture, and were spoken of in the *American Journal of Science* as being the most extensive and systematic efforts of the kind made up to that period. In 1822, also under the patronage of Stephen Van Rensselaer, Mr Eaton undertook a geological and agricultural survey of the district adjoining the Erie canal. The report on this work was published in 1824, in a volume of 163 pages, with a geologic profile extending from the Atlantic to Lake Erie, and a "profile of rocks crossing part of Massachusetts" (from Boston harbor to Plainfield), by the Rev. Edward Hitchcock, who also furnished a description of the rocks and minerals crossed by this profile.

Much had already been done, therefore, to prepare the way, and the public mind was fully awake to the interests and importance of a geological survey, when the Albany Institute, in 1834, memorialized the Legislature for some action in that direction. In 1835 a similar petition was presented by the New York Lyceum of Natural History.

These memorials were referred to a committee of the Legislature of 1835, which recommended a resolution by which the secre-

tary of state was "requested to report to the Legislature at its next session, the most expedient method of obtaining a complete geological survey of the state, which shall furnish a scientific and perfect account of its rocks, soils and minerals, and of their localities; a list of all its mineralogical, botanical and zoological productions, and provide for procuring and preserving specimens of the same; together with an estimate of the expenses which may attend the prosecution of the design, and of the cost of publication of an edition of 3000 copies of the report, drawings and a geological map of the results."

In pursuance of the request contained in this resolution, the secretary of state, Hon. John A. Dix, presented a report[1] at the session of the Legislature in 1836, which contained much valuable information with reference to what had already been done toward developing the mineral resources of the state, giving a summary of our knowledge of the subject at that time, and discussing several questions of great interest; for example, the salt and salt-bearing formations, our mineral springs and the probabilities of finding coal within the limits of the state. He also gave a statement of what had been done in other states, and of work in a similar direction elsewhere in progress or in contemplation.

Under their distinctive heads, he discussed the botany and zoology of the state, and gave reasons why each should receive due attention.

The report concluded with the recommendation of a plan for the geological survey by a subdivision of the state into four districts, a plan which, with some modifications, was carried out in the final organization. This plan contemplated the employment of two geologists for each district, which was subsequently modified by the appointment of one geologist with an assistant, for each district. One mineralogist was appointed for the entire state, and also one botanist and one zoologist.

As shown by the accompanying maps, the first district con-

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[1] Report of the secretary of state in relation to a geological survey of the state, dated Jan. 6, 1836. Assembly doc. no. 9, 1836.

sisted of the counties of Suffolk, Queens, Kings, Richmond, New York, Westchester, Rockland, Putnam, Dutchess, Orange, Sullivan, Delaware, Ulster, Greene, Columbia, Rensselaer, Albany, Schoharie, Schenectady, Saratoga and Washington, containing an area of 12,263 square miles.

The second district consisted of the counties of Warren, Essex, Franklin, Clinton, Hamilton, Jefferson and St Lawrence, making 10,817 square miles.

The third district comprised the counties of Fulton, Montgomery, Herkimer, Oneida, Lewis, Oswego, Madison, Onondaga, Cayuga, Wayne, Ontario, Monroe, Orleans, Genesee and Livingston, making, as reorganized, 11,468 square miles.

The fourth district consisted of the counties of Otsego, Chenango, Broome, Tioga, Chemung, Cortland, Tompkins, Seneca, Yates, Steuben, Allegany, Cattaraugus, Chautauqua, Erie and Niagara, embracing an area of 11,594 square miles.

The third and fourth districts were afterward reorganized, making all the counties to the west of Cayuga lake, and a line drawn north and south from its two extremities, the fourth district, which contained 11,060 square miles.

During the session of 1836 the Legislature passed "an act to provide for a geological survey of the state," authorizing and directing the governor to "employ a suitable number of competent persons, whose duty it shall be, under his direction, to make an accurate and complete geological survey of this state, which shall be accompanied with proper maps and diagrams, and furnish a full and scientific description of its rocks, soils and minerals, and of its botanical and zoological productions, together with specimens of the same; which maps, diagrams and specimens shall be deposited in the State Library; and similar specimens shall be deposited in such of the literary institutions of this state as the secretary of state shall direct."

This act further provided for an annual appropriation for defraying the expenses, and required the persons employed to make an annual report to the Legislature on or before the first

day of February in each year, setting forth the progress made in the survey.

The appointments of the principal geologists were made as follows. Lieut. W. W. Mather, a native of Connecticut, who had lately resigned from the United States army, was assigned to the first district. Prof. Ebenezer Emmons, of Williams College, was assigned to the second district. Mr T. A. Conrad, of Philadelphia, was assigned to the third district, and Mr Lardner Vanuxem, of Bristol Pa., to the fourth district.

The mineralogic department was assigned to Dr Lewis C. Beck, a native of Albany, but at that time a professor in Rutgers College, New Jersey. Dr John Torrey, professor of chemistry and botany in the College of Physicians and Surgeons, New York, was commissioned as state botanist; and Dr James E. De Kay, of Long Island, as state zoologist.

The assistants in geology commissioned by the governor were: Caleb Briggs in the first geologic district, James Hall in the second, George W. Boyd in the third, and James Eights in the fourth district.

The instructions given to these officers were essentially the same as recommended in the report of the secretary of state. Each of the geologists was required to collect, in his own district, eight suites of rock specimens, but no conditions of this kind were imposed on the mineralogist, botanist or zoologist. A special draftsman was appointed for the zoologic department and also for the botanic department. The geologists were each allowed a small sum ($300) annually to pay for the drawings of sections, maps, etc. which might be required for the illustration of their reports.

This, in brief, was the organization of the New York natural history survey at its commencement. At the end of the first year, it became evident to the geologists that the relations of the rock formations, the age and order of superposition, among the then unknown, or very imperfectly understood, stratified deposits, could be determined only on paleontologic evidence. They therefore unanimously recommended to the governor that

some competent person be appointed to devote himself to that department. To this position Mr Conrad was assigned, thus leaving a vacancy in the third geologic district, which, after a reorganization of its boundaries, as before explained, was assigned to the charge of Mr Vanuxem, and Mr Hall was appointed to the fourth district.

During the five years of field work which followed the New York geologists accumulated a vast amount of material and of facts regarding the geologic formations within the state, proving conclusively that they could not be parallel with any of the described and well determined formations of Europe. The Silurian system of Murchison, as described and illustrated in the *Edinburgh Review*, in 1838, and as finally published in 1839, though covering a portion of similar ground, was not broad enough to meet the requirements of the geology of New York. Thus failing to find the means of comparison and identification, the term "New York system," was proposed, to embrace the sedimentary formations from the Potsdam sandstone to the base of the Carboniferous system; or, as the formations were developed in New York and southerly into Pennsylvania, the upward extension of this term reached to the base of the Coal Measures. This term "New York system," included the formations ordinarily embraced by the names Cambrian, Silurian and Devonian in England and on the continent of Europe.

In 1842 Mr Conrad resigned his position as paleontologist of the survey without communicating any report to the governor; and the four geologists who had expected to avail themselves of the results of his investigations were left to their own resources. In this state of affairs, each one of the geologists illustrated his own report, as best he could, by figures of characteristic fossils of the rocks and groups which he had studied in his own district. By this means a very considerable number of the more common and characteristic fossils were illustrated in woodcuts, which were printed in the text, thus giving authentic guides for the determination of all the more important members of the series.

The incompleteness of the plan for the contemplated natural history survey of the state was recognized by the governor and Legislature; and it was also claimed that agricultural interests had not been sufficiently considered in the work already published. It was, therefore, decided that the department of paleontology should be reestablished, and that of agriculture be added to the plan of the work. The paleontology was committed to Mr James Hall, who entered on the work in 1844.

The agriculture of the state was reported on by Dr Ebenezer Emmons. The first of the series of five volumes bearing on this subject contained a somewhat detailed discussion of the general geology of the state, with a statement of the author's views regarding the "Taconic" system. A geologic map was prepared to accompany this volume, which was an almost exact reproduction of the geologic map of 1842, with the exception that the area considered by the author to be occupied by the Taconic system was so colored on the map, though not noted in the accompanying legend. This map was not widely distributed.

During the period from 1844 to 1892 little areal work was carried on, the work of Dr Hall being concentrated on paleontology, but between 1890 and 1892, part of the general museum appropriation had been used for geologic work by the writer.

In 1892 an appropriation was secured from the Legislature for the completion and publication of the geologic map of the state and considerable work was done in tracing boundaries. Subsequent to the publication of this map (the Hall map of 1894) small appropriations were annually made for field work and a certain amount of areal mapping was carried on under the direction of Prof. Hall till his death in 1898.

On the death of Prof. Hall the writer was appointed to succeed him as state geologist, while Dr John M. Clarke was appointed state paleontologist and the work of areal mapping has been continued as rapidly as appropriations would permit.

GEOLOGIC PROVINCES OF NEW YORK

The geologic formations of New York, by their lithologic influence on its physiography and topography, separate themselves into several natural divisions, which have invited and held the attention of many geologists who have devoted themselves to the study of one or another area according to their personal interest and experience.

The more prominent of these which have been made subjects of special study are the Adirondack crystallines, southeastern crystallines, metamorphic rocks of the New England border or Taconic range, Silurian and Lower Devonian rocks of the Mohawk valley region and the Upper Devonian rocks.

Adirondack crystallines

With the exception of a few unimportant papers previously published, geologic work on the pre-Cambrian rocks of the Adirondacks dates from 1837, the first year of field work of the Geological Survey of New York. In the division of the work adopted, by far the larger portion of the area in question fell to the share of Emmons, Vanuxem's district touching it in Lewis, Herkimer and Fulton counties only, while Mather had a small portion in Saratoga and Washington counties. Emmons described various classes of rock in his annual reports and in the final report on the second district, which appeared in 1842. These divisions were based on lithologic differences and were not shown on the 1842 map, on which the entire central mass of the Adirondacks is colored in one tint as "Primary." From 1842 till a comparatively recent date, little or no field work of value was carried on in that area, many of the papers published being in relation to the adoption of the names "Huronian" and "Laurentian" of Canadian geologists for subdivisions of the Adirondack series.

In 1895 Prof. J. F. Kemp, at the suggestion of the writer, took up a study of the region of the iron mines near Port Henry. The results of this work appeared in Museum bulletin 14. Subsequently work was continued under the direction of Prof. James Hall from 1896 to 1898, the study of the Adirondack area being divided between Professors Kemp, Cushing and Smyth.

Pre-Cambrian and metamorphic rocks of southeastern New York

Mather, in his final report of 1842, described the rocks of this area under two heads: metamorphic and primary. In the former he included the mica slates, quartzites and crystalline limestones; in the latter the granites, gneisses and igneous rocks. Though in deference to one of his colleagues, he had given space to the Taconic system, he stated that he believed it to consist merely of altered representatives of Champlain (Cambro-Silurian) age, and further says that the "metamorphic" rocks are probably of the same age, but still more highly altered. On the 1842 map, however, only the limestones are separated out and colored distinct from the "Primary gneisses and granites."

Forty years of reactionary ideas elapsed before the work of Dana and the writer verified Mather's statements, the interval being filled in with the publication of schemes of classification and theories of origin, in which the names Laurentian, Huronian, Norian and Montalban figured prominently. The difficulty of establishing these theories without actual field work was apparently not manifest to some of the authors.

The history of modern geologic work in the region dates back less than a quarter century. Dana, in the extension of his work on the Taconic rocks, carefully worked over Dutchess, Putnam, Westchester and New York counties; and correlated the crystalline limestones of the last two with the Cambro-Silurian limestones of Dutchess county. Failing, however, to differentiate the mica schist (Manhattan or Hudson) overlying the limestones (Inwood or Stockbridge) from the gneisses (Fordham) underlying them, his work lacked completeness. This want was supplied by the writer, who recognized the dissimilarity and true stratigraphic positions of the two noncalcareous formations, and correlated the Manhattan schist with the Hudson river slates and shales.[1] Detecting also the presence in these counties of a comparatively thin bed of quartzite (Lowerre) immediately below the limestones, he inferred its equivalence to the Cambrian quartzite of Dutchess county. The series was

[1] Am. Jour. Sci. Ser. 3. 39:389; N. Y. State Mus. 50th An. Rep't. 1:21-31.

thus found to be complete and the positions of its members well established. Subsequently the positions and boundaries of these members have been located in detail throughout the southeastern counties by the writer and his assistants, Messrs Blake, Ries, Newland, Hill and Eckel.

The rocks of the Taconic range and adjoining areas

Most of the so called "Taconic" rocks fell, on the first geological survey of the state, within the district assigned to Mather, who appears to have recognized their true character and relationship. Emmons, however, insisted that they formed a separate and distinct system underlying the Silurian, and his views were accepted, under protest, by Mather in his final report. Owing to the later advocacy of Emmons's views by Hunt and Marcou, neither of whom performed any field work in the region, the "Taconic question" left a marked impression on the literature of New York and New England geology. The subsequent work of Dana and Walcott was, however, decisive, and since then the only problem has been the exact correlation, so far as exactness is possible, of these Taconic rocks with the unmetamorphosed strata of the Cambrian and Silurian formations.

So far as the area covered by Dale in his work on the slate belt falls within the limits of the 1901 map, his boundaries and correlations have been followed. Maps from several of his other papers have been used for smaller areas, while some areas on the eastern border are taken from the maps of Pumpelly and Emerson. Dwight's manuscript maps contributed for the occasion have been followed for most of Dutchess county, north of the Highlands.

With the exception of small areas near Lake Champlain, credited to Brainerd and Seely, the remaining part of the Paleozoic mapped east of the Hudson is from the work of Dana and Walcott. Dana's mapping covers a relatively small area in northeastern Dutchess and southeastern Columbia county and in the adjoining portions of Massachusetts and Connecticut; while Walcott's boundaries have been followed for most of Rensselaer and Washington counties and nearly all that part of Vermont which appears on the map of 1901.

Silurian and Lower Devonian

The most interesting problems connected with these formations are those of the proper systematic position of the Lower Helderberg and the mutual relations of the Medina sandstone, Oneida conglomerate and Oswego sandstone. The first subject has been discussed by Clarke, Williams, Stevenson and others; while the second remains to be investigated. The mapping of the Cambrian and Silurian formations in the Lake Champlain region is based on the work of Brainerd and Seely, Cushing, Kemp, van Ingen, Walcott and White, all save van Ingen's contribution having appeared in various papers.

The mapping of the pre-Hamilton rocks in the western and northern towns of Orange county is based on the work of Ries; that of the Schunemunk-Bearfort mountain area on Darton's, retraced on the Schunemunk and Ramapo atlas sheets by Eckel. With the exception of the small areas about Kingston and Hudson credited to Davis, Darton's work for the Hall map of 1894 served as the basis for the pre-Hamilton mapping of Ulster, Greene and Albany counties and for the westward extension of the Helderberg rocks across the state. His mapping of the Niagara limestone was also used, supplemented by later work by Sarle, who is to be credited with the Medina-Clinton and Clinton-Niagara boundaries from Oneida lake to Lockport, and with the Potsdam-Trenton, Trenton-Hudson and Hudson-Medina boundaries from near Boonville and Rome to Lake Ontario. Westward of Lockport a manuscript map by Gilbert and the recently published map by Grabau, of the vicinity of the Niagara river, were used. The mapping in Erie county south of Buffalo is based on the work of Bishop, with corrections by Clarke. The boundaries in Onondaga county are mainly as mapped by Luther; while small areas near Skaneateles, and in Oneida county near Oneida, Clinton and Utica were revised by Eckel.

In addition to the work on the areas specified above, Clarke and Luther made many manuscript corrections to the boundaries shown on the map of 1894 in the central and western part of

the state, the Hall map of 1894 being used where no information of later date was obtainable.

In the Mohawk valley the mapping of the Paleozoic is based largely on Darton's work under the direction of the late James Hall. The boundary between the Cambrian and the Silurian, north of the Adirondacks, is to be credited to Cushing. White's mapping, revised in some places by Eckel, was used for the Lower Silurian formations in most of Oneida county and in parts of Herkimer and Lewis.

The Upper Devonian and the Carboniferous

The mapping of the formations above the Onondaga on the present edition of the geologic map is based, east of the Chenango valley, on the work of Prosser, except in Albany county, where Darton's boundaries have been used. West of the Chenango valley it is based mainly on recent published and unpublished work of Dr John M. Clarke, aided by Luther in some areas, the portion not thus recently revised being copied from the Hall map of 1894. The position of the Tully limestone, first mapped by S. G. Williams, has been revised by Luther throughout most of its length and by Eckel in that portion appearing on the Ovid atlas sheet.

The Carboniferous outliers in the southwestern part of the state are as mapped, in manuscript, by Clarke after Randall, but are not considered by Dr Clarke to be very reliably determined.

Triassic to Pleistocene

The Triassic sandstone and diabase of Rockland county are as mapped by Kümmel. The pre-Pleistocene boundaries on Staten Island are based on the mapping of Hollick; the Pleistocene of Staten Island and Long Island are from the mapping of Woodworth and Woodman. Their respective areas were separated by the meridian of 73° 30′, Woodworth mapping all west and Woodman all east of that line. The continuation of the moraine across New Jersey and Pennsylvania is credited to Salisbury and Lewis.

LIST OF MAPS SHOWING GEOLOGY OF NEW YORK STATE

DATE	AUTHOR	AREA	SCALE TO INCH	MEDIUM OF PUBLICATION
1830..	Amos Eaton	N. Y	30 m.	Geological Textbook
1842..	Geol. Survey N. Y	N. Y	12 m.	To accompany the geologic reports
1843..	James Hall	N. Y. & central western states	30 m.	Report on the 4th Geologic District of New York
1844..	Ebenezer Emmons	N. Y	12 m.	To accompany the Report on the Agriculture of New York
1845..	Sir Charles Lyell	Canada & U. S	125 m.	Travels in North America
1863..	Sir William Logan & James Hall.	Canada & northeastern U. S.	125 m.	Report on the Geological Survey of Canada
1865..		N. Y	20 m.	On the margin of J. H. French's map of N. Y. state
1867..	Sir William Logan & James Hall.	Canada & northeastern U. S.	25 m.	Accompanying Report on the Geological Survey of Canada
1871..	Charles H. Hitchcock	N. Y	25 m.	Asher & Adams's atlas of New York
1881..	Charles H. Hitchcock	U. S.	20 m.	Published for the author by Julius Bien & Co.
1882..	James Hall	N. Y.	38 m.	Public Service of the State of New York
1884..	W J McGee	U. S.	112 m.	U. S. Geological Survey. 5th report
1886..	Charles H. Hitchcock	U. S.	112 m.	American Institute of Mining Engineers. Transactions. v. 15
1886..	Charles H. Hitchcock	N. Y.	25 m.	10th Census Report, v. 15
1888..	Charles A. Ashburner	Southwestern N. Y.	25 m.	American Institute of Mining Engineers. Transactions. v. 16
1893..	W J McGee	U. S.	112 m.	U. S. Geological Survey. 14th report
1894..	Frederick J. H. Merrill	N. Y.	14 m.	N. Y. State Museum. Bul. 15; also New York at World's Columbian Exposition, 1893
1894..	James Hall	N. Y.	5 m.	
1897..	Frederick J. H. Merrill	N. Y.	25 m.	N. Y. State Museum. Bul. 17
1898..	Frederick J. H. Merrill	Relief map showing geologic systems of N. Y.	25 m.	N. Y. State Museum. Bul. 19
1901..	Frederick J. H. Merrill	N. Y.	5 m.	

EARLIER GEOLOGIC MAPS AND THEIR GEOGRAPHIC BASES

The maps of 1842 and 1844

The condition of the geographic maps of New York in 1842 can best be shown by quoting the words of Prof. Hall.[1]

Upon the organization of the Geological Survey of the State of New York, one of the first objects sought was a map for laying down the limits of the geological formations. At that time there were no accurate maps except of small parts of country, and the best resource was found in Burr's atlas of the state and county maps of the State of New York. There seems to have been no approximately correct geographic map of the state available for the use of the geologists in recording their observations. At the close of the survey a small map was engraved expressly for the use of the geologists in laying down the limits of the geological formations. This map from the eastern limits of the state adjoining Massachusetts, Connecticut and Vermont to its western extremity was about 28 inches, and its extreme limit from north to south along the eastern counties of the state or from the Canada line to Sandy Hook was 2 inches less than its extent from east to west, or 26 inches. The locations of towns, villages and postoffices were doubtless taken from the best maps extant, but these afforded very unsafe guides for locating the outcrops of the geological formations.

Emmons's map of 1844 was colored on the same base as the map of 1842.

In 1867 a geologic map of Canada and the northern and eastern United States was published by Sir William Logan, director of the Canadian Geological Survey. This map is on a scale of 25 miles to the inch, and is of interest in the present connection because of the fact that the geology of the United States was compiled for it by Prof. Hall. The geologic mapping of New York there shown is, therefore, the first authoritative revision of the 1842 geologic map of New York.

Of this map it is said that only three copies were sent to the United States. These were presented to Prof. James Hall, Prof. James D. Dana and the United States Coast Survey. A reproduction on the scale of 125 miles to the inch is contained in the atlas accompanying the report of progress of the Canadian Geological Survey for 1863.

[1] N. Y. State Geol. 12th An. Rep't. 1893. p. 27.

In 1882 Dr Hall prepared a small black and white geologic map of the state on the scale of 38 miles to the inch to accompany a publication entitled *Public Service of the State of New York.*

In 1894 an "Economic and Geologic Map of the State of New York" was prepared by F. J. H. Merrill to illustrate the report of the board of managers of the exhibit of the State of New York at the World's Columbian exposition. The scale was 14 miles to the inch, and the detail was necessarily much generalized, but in some areas the geologic boundaries were based on more recent data than those shown on the large map prepared under the direction of Prof. Hall.

A later edition of this map was published in bulletin 15 of the New York State Museum, and a reprint of this edition is contained in the report on barge canal by the state engineer, 1901.

The geographic base of 1894

The base of 1894 was prepared for Prof. Hall in Washington under the direction of Mr W J McGee, from such cartographic material as was available at that date. The manuscript draft of the base was prepared by Messrs Klemroth and Torbert on the same scale as that of the publication. The engraving was done on copper by expert engravers of the United States Coast and Geodetic Survey, temporarily unemployed.

While this map is very beautifully engraved, it is not wholly accurate in its geography, owing to the incompleteness of the surveys of the state and the lack of good compilations of such surveys as had been carefully made.

An edition of 1000 copies was printed.

The geographic base of 1901

The lack of accurate geographic information concerning New York state at the time of the compilation of the base of the Hall map rendered it necessarily inaccurate and, though beautifully engraved on copper, the errors were so numerous, which could be corrected through the availability of later surveys at the time of preparing the new edition, that the cost of correcting the

copper plates would have been nearly as great as the expense of the original engraving. It was, therefore, decided to use for the new edition the less expensive method of photo-lithographic reproduction and leave to a future period, when the topographic survey of the state might be completed, the engraving of a new copper plate base of which the accuracy might be unquestioned.

The compilation of the manuscript geographic base was made by draftsmen under the supervision of Mr C. C. Vermeule, on the scale of 2½ miles to the inch, using all atlas sheets that had been surveyed at that time. In areas for which atlas sheets had not yet appeared the most accurate county maps were followed. The lithographic work was done by Julius Bien & Co., and after the proofs of the base were submitted they were again revised with the help of all later topographic sheets that appeared up to the time of going to press. The compilation of the geology was made with great care, preparation for it being the compilation during the previous year of a manuscript map of the state on a scale of 12 miles to the inch, in order to bring together all the latest material and to form a definite idea of its adjustment. Detailed credit for the material used is given in the text of this bulletin and in the important work of adjustment the writer has been greatly aided by his assistant Mr E. C. Eckel. The drafting of the geologic boundaries on the new base was mainly done by Mr A. M. Evans to whose manual skill and geographic instinct much of the value of the map as an accurate reproduction is due.

It should be understood by those who use the map that a certain percentage of the boundaries shown on it are necessarily conjectural. Some, because they have not yet been carefully surveyed on topographic sheets; some because the extent of Quaternary deposits is so great as to render these boundaries, in a large measure, indeterminate. One of the more prominent examples of the latter class is the boundary between the Niagara and Salina formations, west of the Genesee river. It can not be promised that this boundary will ever be defined with any degree of certainty unless a very extensive system of borings be made.

COLOR SCHEME

The colors and patterns used for the expression of the geologic formations are as nearly as possible those adopted by the United States Geological Survey in its geologic maps. The adjustment of these conventions to so large a map has proved quite difficult, yet it is sufficiently close to be clearly intelligible to those familiar with the system in question.

ACKNOWLEDGMENTS FOR MATERIAL USED

The space necessary for a detailed acknowledgment of material used in the present edition of the geologic map of New York is so great that it was found impracticable to engrave it all on the map itself. In the following pages, therefore, a detailed acknowledgment is made for all material used.

LIST OF CONTRIBUTING GEOLOGISTS WITH COUNTIES IN WHICH THEIR CONTRIBUTIONS LIE

New York

Bishop, I. P. Erie.

Clarke, J. M. Albany, Allegany, Broome, Cattaraugus, Cayuga, Chautauqua, Chemung, Chenango, Columbia, Cortland, Genesee, Herkimer, Livingston, Madison, Monroe, Oneida, Onondaga, Ontario, Otsego, Schuyler, Seneca, Steuben, Tioga, Tompkins, Wyoming and Yates.

Cumings, E. R. Schenectady.

Cushing, H. P. Clinton, Franklin, Herkimer and St Lawrence.

Dale, T. N. Rensselaer and Washington.

Dana, J. D. Columbia and Rensselaer.

Darton, N. H. Albany, Greene, Ulster, Orange, Saratoga, Herkimer, Fulton, Hamilton and Montgomery.

Davis, W. M. Columbia and Ulster.

Dwight, W. B. Dutchess and Columbia.

Eckel, E. C. Westchester, Putnam, Dutchess, Rockland, Orange, Oneida, Seneca and Yates.

Finlay, G. I. Essex.

Ford, S. W. Columbia.

Gilbert, G. K. Niagara.

Grabau, A. W. Niagara and Erie.

Hall, James. Schoharie, Sullivan, Tioga, Tompkins, Ulster, Wayne, Delaware, Monroe, Livingston, Broome, Cayuga, Chenango, Cortland, Erie, Greene, Genesee, Herkimer, Madison, Oneida, Orleans and Otsego.

Hill, B. F. Hamilton, Putnam, Washington, Dutchess, Fulton, Warren and Montgomery.

Hollick, A. Richmond.

Kemp, J. F. Essex, Fulton, Hamilton, Saratoga, Warren, Washington, Montgomery and Rockland.

Kümmel, H. B. Rockland.

Lincoln, D. F. Seneca.

Luther, D. D. Allegany, Broome, Cattaraugus, Cayuga, Chautauqua, Chemung, Cortland, Erie, Genesee, Livingston, Madison, Onondaga, Ontario, Seneca, Steuben, Tompkins, Wyoming and Yates.

Merrill, F. J. H. Queens, New York, Westchester, Putnam, Dutchess, Ontario and Rockland.

Newland, D. H. Dutchess, Putnam, Hamilton, Warren and Washington.

Parsons, A. L. Livingston.

Prosser, C. S. Schenectady, Otsego, Delaware, Schoharie, Greene, Orange, Sullivan, Albany, Ulster, Madison and Chenango.

Ries, H. Westchester, Orange and Putnam.

Sarle, C. J. Niagara, Orleans, Monroe, Wayne, Cayuga, Oneida, Oswego, Lewis, Jefferson and Madison.

Smyth, C. H. jr. Hamilton, Herkimer, Jefferson, Lewis, St Lawrence and Oneida.

van Ingen, G. Clinton and Essex.

Walcott, C. D. Rensselaer, Washington and Columbia.

White, T. G. Essex, Herkimer, Oneida and Lewis.

Woodman, J. E. Nassau and Suffolk.

Woodworth, J. B. Richmond, Kings, Queens and Nassau.

LIST OF GEOLOGIC MAPS USED IN PREPARATION

Clarke, J. M. New York State Geologist. 4th Annual Report. 1885. p. 9.

1 Geologic map of Ontario county.

——— New York State Geologist. 15th Annual Report. 1898.

2 Geologic map of Seneca, Schuyler, Yates and parts of Tompkins and Ontario counties. p. 60.

3 Geologic map of part of Chenango and Cortland counties. p. 42.

——— New York State Museum. Memoir 3. 1900. p. 12.

4 Geologic map of Becraft mountain.

Cushing, H. P. New York State Geologist. 15th Annual Report. 1898.

5 Geologic map of town of Champlain, Clinton co. p. 572.

6 Geologic map of Chazy town, Clinton co. p. 567.

7 Geologic map of town of Plattsburg, Clinton co. p. 556.

8 Geologic map of town of Beekmantown, Clinton co. p. 561.

9 Geologic map of town of Altona, Clinton co. p. 563.

10 Geologic map of towns of Plattsburg and Schuyler Falls, Clinton co. p. 553.

11 Geologic map of town of Peru, Clinton co. p. 550.

12 Geologic map of town of Ausable, Clinton co. p. 546.

13 Geologic map of town of Black Brook, Clinton co. p. 542.

14 Geologic map of town of Saranac, Clinton co. p. 539.

15 Geologic map of town of Dannemora, Clinton co. p. 536.

16 Map of Clinton co., showing boundary between Cambrian and pre-Cambrian formations. pl. 1, p. 503.

17 Map of Ellenburg, Clinton co. p. 553.

——— New York State Geologist. 16th Annual Report. 1899.

18 Map of Potsdam-pre-Cambrian boundaries in Clinton, Franklin and St Lawrence counties. p. 4.

19 Map of a portion of towns of Potsdam and Pierrepont, St Lawrence co. p. 25.

——— New York State Geologist. 18th Annual Report. 1900.

20 Geologic map of Franklin county.

Dale, T. N. United States Geological Survey. 13th Annual Report. 1893. pt 2, pl. 97.

21 Geologic map of the region between the Taconic range and the Hudson valley.

——— United States Geological Survey. 19th Annual Report. 1899. pt 3, pl. 13.

22 Geologic map of the slate belt of eastern New York and western Vermont.

Dana, J. D. American Journal of Science. Ser. 3, no. 120. Dec. 1880. 20:450, pl. 8.

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26 Preliminary geologic map of portions of Herkimer, Fulton, Montgomery, Saratoga and adjacent counties. p. 33.

27 Sketch map of region north of Mayfield, Fulton co. p. 46.

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33 Geologic map of towns of Moriah and Westport, Essex co.

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34 Geologic map of the town of Chesterfield, Essex co. p. 580.

35 Geologic map of the town of Wilmington, Essex co. p. 586.

36 Geologic map of the town of St Armand, Essex co. p. 588.

37 Geologic map of the town of North Hudson, Essex co. p. 590.

38 Geologic map of the town of Schroon, Essex co. p. 592.

39 Geologic map of the town of Ticonderoga, Essex co. p. 600.

40 Geologic map of the town of Minerva, Essex co. p. 602.

41 Geologic map of the town of Newcomb, Essex co. p. 604.

42 Geologic map of the town of Jay, Essex co. p. 582.

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43 Geologic map of vicinity of Lake Placid.

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44 Geologic map of the town of Putnam, Washington co. p. 512.

45 Geologic map of the town of Dresden, Washington co. p. 514.

46 Geologic map of the town of Whitehall, Washington co. p. 520.

47 Geologic map of Whitehall village and region to the west. p. 522.

48 Geologic map of the town of Fort Ann, Washington co. p. 530.

49 Geologic map of the town of Bolton, Warren co. p. 534.

50 Geologic map of the town of Chester, Warren co. p. 536.

51 Geologic map of the town of Hague, Warren co. p. 538.

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53 Geologic map of the vicinity of Wells village, Hamilton co. p. 144.

54 Geologic map of the town of Johnsburg, Warren co. p. 158.

55 Geologic map of the town of Fort Ann, Washington co. p. 162.

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56 Geologic map of the town of Caldwell, Warren co. p. 22.

57 Geologic map of the town of Queensbury, Warren co. p. 26.

58 Geologic map of the northern part of Saratoga county. p. 28.

59 Geologic map of the northern part of Fulton county. p. 29.

60 Outline map of the "Noses," Montgomery co. p. 32.

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62 Geologic map of Seneca county.
Map omitted from v. 2 of 48th museum report, where it should also have appeared.

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63 Geologic map of the town of Naples, Ontario co. p. 236.

64 Geologic map of Onondaga county. p. 302.

Merrill, F. J. H. New York State Museum. Bulletin 15. 1895. p. 595.

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66 Geologic map of parts of Chenango, Madison, Otsego, Schoharie and Albany counties.

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69 Augen gneiss area near Bedford N. Y.

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70 Orange county. p. 395.

71 Town of Warwick, Orange co. p. 408.

72 Towns of Monroe, Woodbury, Highlands, Cornwall and a part of the town of Blooming Grove, Orange co. p. 414.

73 Area around Bull hill, Orange co. p. 423.

74 Geologic map and sections of regions west of Cornwall, Orange co. p. 427.

75 Geologic map of the town of Chester, Orange co. p. 428.

76 Geologic map of the town of Deer Park, Orange co. p. 470.

77 Geologic map of the town of Hamptonburgh, Orange co. p. 472.

78 Geologic map of the towns of Newburgh and New Windsor, Orange co. p. 476.

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79 Geologic map of portions of St Lawrence and Jefferson counties.

Walcott, C. D. American Journal of Science. Ser. 3, no. 208. 1888. 35:346, pl. 3.

80 Map of the Taconic region.

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81 Geologic map of towns of Essex and Willsboro, Essex co.

——— New York State Museum. 51st Annual Report. 1899.

82 Geologic map of the pre-Cambrian border in Oneida and Lewis counties. p. r54.

83 Geologic map of the vicinity of Frankfort Hill. p. r54.

LIST OF AUTHORITIES FOR THE COUNTIES OF NEW YORK

Albany. Below top of Hamilton, Darton (28); corrected as to Oriskany in towns of Knox and New Scotland by Clarke; above base of Hamilton, Prosser (67).

Allegany. Portage-Chemung boundary by Clarke and Luther. Areas of Catskill in Hall (31) omitted.

Broome. Hall (31) corrected by Clarke and Luther in towns of Triangle and Lisle.

Cattaraugus. Clarke and Luther. Carboniferous compiled by Clarke after Randall.

Cayuga. Hall (31) corrected in towns of Aurelius and Springport and city of Auburn by Clarke; Tully and Genesee-Portage boundaries by Clarke and Luther; Clinton by Sarle.

Chautauqua. Clarke and Luther.

Chemung. Clarke and Luther.

Chenango. Hall (31); west of Chenango river; Clarke (3) and manuscript; east of Chenango river, Prosser (66).

Clinton. Cushing (5–18 incl.); with corrections and additions by Cushing.

Columbia. Eastern part, Dana (24, 25); northwest part, Walcott (80); region about Hudson, Clarke (4); Cambrian boundary at Hudson river, Ford (29); remainder of county by Dwight.

Cortland. Clarke (3), Hall (31) corrected by Clarke and Luther.

Delaware. Hall (31), Prosser (66) upper and lower boundaries of Ithaca, Oneonta-Chemung boundary west of Meredith.

Dutchess. Town of Pawling by Merrill except pre-Cambrian boundary from Whaley Pond to northern limit of this formation by Hill; town of Amenia from Wassaic northward by Merrill;

pre-Cambrian and Cambrian of Dover mountain by Eckel; town of Fishkill by Newland and Eckel; East Fishkill and Beekman by Hill; other boundaries by Dwight.

Erie. Hall (31) corrected by Clarke and Luther and I. P. Bishop; Salina-Onondaga boundary near Buffalo, Grabau (30).

Essex. Kemp (33–43) and manuscript; town of Minerva, Finlay; Willsboro Point by White (81) corrected by Kemp; Crown Point Paleozoic corrected by van Ingen.

Franklin. Cushing (18, 20) corrected by Cushing.

Fulton. Darton (26, 27); Kemp and Hill (59).

Genesee. Onondaga and below Hall (31), corrected by Clarke in towns of Alabama, Pembroke and Leroy; above base of Hamilton by Clarke and Luther.

Greene. Hall (31), Oneonta-Chemung and Chemung-Catskill; upper and lower boundaries of Ithaca, Prosser (67).

Hamilton. Northwestern part by Smyth, eastern part, Kemp (52, 53).

Herkimer. Hall (31), corrected in town of Litchfield by Clarke; Little Falls crystalline area by Cushing, White (83); Darton (26).

Jefferson. Pre-Cambrian boundaries, Smyth (79); Paleozoic boundaries above base of Potsdam by Sarle.

Kings. Woodworth.

Lewis. Pre-Cambrian, White (83) and Smyth; others by Sarle.

Livingston. Hall (31), corrected in towns of Caledonia and Lima by Clarke; top of Hamilton to base of Chemung, Clarke and Luther; corrected in town of Mount Morris by A. L. Parsons.

Madison. Hall (31) corrected as to Lower Helderberg by Clarke; Prosser (66); Tully by Luther; Clinton-Niagara and Niagara-Salina by Sarle.

Monroe. Hall (31) corrected in towns of Brighton, Mendon, Rush and Wheatland by Clarke; Medina-Clinton and Clinton-Niagara boundaries by Sarle.

Montgomery. Darton (26); "Noses" area, Kemp and Hill (60).

Nassau. West of 70° 30′ by Woodworth; east of that meridian by Woodman.

New York. Merrill (65).

Niagara. Region near Niagara river, Grabau (30); Clinton other boundaries by Gilbert and Sarle.

Oneida. Hall (31), corrected in towns of Augusta, Marshall and Paris by Clarke, in Kirkland by Smyth, and in Paris, Kirkland and Vernon by Eckel; below top of Niagara by Sarle and White (82, 83).

Onondaga. Luther (64), corrected as to Helderberg and Salina by Clarke; Tully resurveyed by Luther.

Ontario. Clarke (1, 2), corrected by Clarke; Tully by Luther. Boundaries in towns of Seneca, Phelps and city of Geneva by Merrill after well records.

Orange. Schunemunk area of Paleozoic rocks by Darton; east and south of that area by Eckel; west and north of the Schunemunk area, Ries (70–78); Deer Park, Prosser (67).

Orleans. Hall (31), adjusted to topography.

Oswego. Sarle.

Otsego. Hall (31) below Hamilton; above base of Hamilton, Prosser (67); corrected in towns of Laurens and New Lisbon by Clarke.

Putnam. Southern parts of Phillipstown and Putnam Valley, Merrill (65); Patterson, East Kent and southern Southeast by Merrill; limestones between Anthony's Nose and Cold Spring and in valleys of Sprout brook and Canopus creek by Newland; remainder of the county from reconnaissance by Hill.

Queens. Crystalline rocks, Merrill (65); Pleistocene by Woodworth.

Rensselaer. Rensselaer grit plateau and vicinity, Dale (21); portions of the southeast part, Dana (25); remainder, Walcott (80).

Richmond. Pre-Pleistocene by Hollick; Pleistocene by Woodworth.

Rockland. Triassic, Kümmel (61); pre-Cambrian and Paleozoic boundaries in town of Stony Point, Merrill; towns of Ramapo and Haverstraw by Eckel; eruptives near Rosetown, Kemp (32).

St Lawrence. Smyth (79) and Cushing (18); corrected by Cushing.

Saratoga. Darton (26); Kemp (58).

Schenectady. Darton (26); except Amsterdam quadrangle by Cumings and Prosser (68).

Schoharie. Hall (31); top of Hamilton and Ithaca-Oneonta boundaries by Prosser (66 and 67).

Schuyler. Clarke (2). Relation of Ithaca and Naples beds of the Portage group diagrammatically shown as necessitated by map patterns.

Seneca. Lincoln (62), corrected by Clarke and Luther; Tully limestone within Ovid quadrangle by Eckel; relation of Ithaca and Naples beds of Portage, Clarke (2), diagrammatically shown as necessitated by patterns of map.

Steuben. Clarke and Luther.

Suffolk. Woodman.

Sullivan. Hall (31); top of Hamilton and above, Prosser (67).

Tioga. Hall (31).

Tompkins. Hall (31); Clarke (2); and Tully and Genesee, Luther.

Ulster. Hall (31); top of the Hamilton and above, Prosser (67).

Warren. Kemp, Newland and Hill (49–51, 54, 56, 57), corrected by Kemp.

Washington. Kemp and Hill (44–48, 55); Dale (22); Walcott (81).

Wayne. Niagara-Salina boundary by Hall (31); others by Sarle.

Westchester. Merrill (65); except in town of Bedford, Ries (69); and in towns of Cortlandt, Yorktown, Somers, North Salem, Lewisboro, Poundridge, Bedford, North Castle, Newcastle and Harrison by Eckel.

Wyoming. Clarke and Luther.

Yates. Genesee-Portage and Portage-Chemung, Clarke (2) corrected by Clarke and Luther; Tully limestone by Luther except near Dresden by Eckel.

LIST OF AUTHORITIES FOR CONNECTICUT, MASSACHUSETTS, VERMONT, NEW JERSEY AND PENNSYLVANIA

Connecticut. Dana (23, 24 and 25) modified by unpublished results of reconnaissance by Eckel in towns of Greenwich, Stamford, New Canaan and Darien and H. C. Magnus in towns of Salisbury and Sharon.

Massachusetts. Dana (24, 25) except in the area covered by Dale (21 and the geologic map of Monument mt, U. S. Geol. Sur., 14th An. Rep't), Emerson (U. S. Geol. Sur. Bul. 259 and U. S. Geol. Sur. Monograph 23, pl. 1), Pumpelly, Dale, Wolff and Hobbs.

Vermont. Walcott (80); Dale (22); and Brainerd and Seely.

New Jersey. J. C. Smock (New Jersey geologic map of 1890); except Green Pond mt region, by Darton (Geol. Soc. Am. Bul. 5: 367) as engraved on the Hall map (31); area about Franklin by Wolff and Brooks (U. S. Geol. Sur. 19th An. Rep't); moraine by Salisbury (N. J. state geologist. Rep't 1895).

Pennsylvania. I. C. White (G 6), H. C. Lewis (Q), Frederick Prime jr (D 3) and B. S. Lyman (2d Geol. Sur. Summary Rep't, v. 3)

MANUSCRIPT MAPS

A number of manuscript maps and manuscript corrections embodying the results of unpublished field work, were used in the compilation of the geology of the present map.

A manuscript map of the boundaries above the base of the Portage from Cayuga lake westward was supplied by Dr John M. Clarke, state paleontologist, embodying the results of field work by himself and his assistant, Mr D. D. Luther up to 1898.

Dr Clarke also contributed, as noted above, numerous manuscript corrections of existing maps.

Mr C. J. Sarle, who had been engaged under Prof. James Hall in field work on the Upper Silurian formations of the central and western parts of the state, contributed manuscript maps showing the results of this work.

Mr N. H. Darton, whose mapping of the rocks of the Helderberg escarpment had been used on the Hall map, contributed his original manuscript drafts.

For the Adirondack area Professors Cushing, Kemp and Smyth mapped in manuscript their respective areas of work, much of which had been left uncovered by their published maps. Several of the maps used in manuscript have since been published.

Manuscript maps by G. K. Gilbert, covering parts of the Upper Silurian area of Niagara county and a revision by I. P. Bishop of parts of his map of Erie county were also used.

Prof. W. B. Dwight contributed in manuscript the results of his field work in Dutchess county.

In southeastern New York, field work by the writer and his assistants furnished a large amount of unpublished material.

Long Island was mapped in manuscript by Prof. J. B. Woodworth and his assistant, J. E. Woodman, as the result of field work for the State Museum. Part of the area thus covered has since been described with accompanying maps in Museum bulletin 48.

NOMENCLATURE OF NEW YORK GEOLOGY

In selecting names to be applied to the formations shown on the map the attempt has been made to render it as serviceable as possible to the teacher and student by keeping its nomenclature as close as possible to the mass of older textbooks now in use.

In so doing the editor has not followed in every case the latest expression in terminology or classification, and has not undertaken to decide the merits of any question at issue.

Perhaps the most prominent question of geologic classification in New York now under discussion is that of the systematic position of the Helderberg limestone; namely whether it should be regarded as Silurian or Devonian. Dr John M. Clarke, state paleontologist, after exhaustive study, has expressed the opinion that in this formation fossils of Devonian aspect appear and that it should, consequently, be included in the Devonian system. Prof. H. S. Williams, attacking the question from another point of view, in his studies of the Paleozoic formations of Maine,[1]

[1] U. S. Geol. Sur. Bul. 165, p. 56.

finds the Square Lake limestone which he correlates by its fossils with the Helderberg formation of New York and above it the Chapman sandstone in which he finds forms representative of the Silurian Tilestone fauna of Great Britain. From this he argues that, inasmuch as these Silurian fossils occur in a formation more recent than the Helderberg limestone, the latter should be regarded as Silurian.

So far as the writer understands from the literature to which he has access, the authors referred to, do not dispute each other's identifications of fossils. The question then seems to hang on the definition of a system; Dr Clarke holding that the system begins where its faunas first appear, while Prof. Williams holds that a system continues as far as its faunas linger, the definition of a system having, apparently, not been previously fixed. The question would, therefore, seem to remain open till the majority of geologists take the one side or the other.

On inquiring the opinion of the director of the United States Geological Survey, he expressed the view that the matter was still unsettled and so it is left by the present writer, the Helderberg being for the purposes of the present map classified in the Silurian system according to the arrangement adopted by Prof. Hall in the geologic map of 1894.

The classification of Oneonta, Ithaca and Portage formations as given on the map is based on a paper by Dr John M. Clarke in the 15th annual report of the state geologist, in which these formations, though regarded as essentially of equal age, lying between Hamilton and Chemung, are treated as separate groups. In the classification printed by Dr Clarke in Memoir 3 of the New York State Museum, he proposes to give the name of Portage group to the aggregate of the three formations and use the term Naples for the formation designated in the previous paper as the Portage group.

The following table shows the progress made in the terminology and classification of the rocks of New York since the beginning of geologic study within its area.

INDEX

University of the State of New York

New York State Museum

MUSEUM PUBLICATIONS

Any of the University publications will be sold in lots of 10 or more at 20% discount. When sale copies are exhausted, the price for the few reserve copies is advanced to that charged by secondhand booksellers to limit their distribution to cases of special need. Such prices are inclosed in brackets.

All publications are in paper covers, unless binding is specified.

Museum annual reports 1847–date. *All in print to 1892, 50c a volume, 75c in cloth; 1892–date, 75c, cloth.*

These reports are made up of the reports of the director, geologist, paleontologist, botanist and entomologist, and museum bulletins and memoirs, issued as advance sections of the reports.

Geologist's annual reports 1881–date. Rep'ts 1, 3-13, 17–date, O.; 2, 14-16, Q.

The annual reports of the early natural history survey, 1836-42 are out of print.

Reports 1-4, 1881-84 were published only in separate form. Of the 5th report 4 pages were reprinted in the 39th museum report, and a supplement to the 6th report was included in the 40th museum report. The 7th and subsequent reports are included in the 41st and following museum reports, except that certain lithographic plates in the 11th report (1891), 13th (1893) are omitted from the 45th and 47th museum reports.

Separate volumes of the following only are available.

Report	*Price*	*Report*	*Price*	*Report*	*Price*
12 (1892)	$.50	16	$1	19	$.40
14	.75	17	.75	20	.50
15	1	18	.75		

In 1898 the paleontologic work of the State was made distinct from the geologic and will hereafter be reported separately.

Paleontologist's annual reports 1899–date.

See fourth note under Geologist's annual reports.

Bound also with museum reports of which they form a part. Reports for 1899 and 1900 may be had for 20c each. Beginning with 1901 these reports will be issued as bulletins.

Botanist's annual reports 1869–date.

Bound also with museum reports 22–date of which they form a part; the first botanist's report appeared in the 22d museum report and is numbered 22.

Reports 22-41, 48, 49, 50 and 52 (Museum bulletin 25) are out of print; 42-47 are inaccessible. Report 51 may be had for 40c; 53 for 20c; 54 for 50c. Beginning with 1901 these reports will be issued as bulletins.

Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have been published in volumes 1 and 3 of the 48th museum report and in volume 1 of the 49th, 51st and 52d reports. The botanical part of the 51st is available also in separate form. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged, and combined with others more recently prepared constitute Museum memoir 4.

Entomologist's annual reports on the injurious and other insects of the State of New York 1882–date.

Bound also with museum reports of which they form a part. Beginning with 1898 these reports have been issued as bulletins. Reports 3-4 are out of print, other reports with prices are:

Report	*Price*	*Report*	*Price*	*Report*	*Price*
1	$.50	8	$.25	13	$.10
2	.30	9	.25	14 (Mus. bul. 23)	.20
5	.25	10	.35	15 (" 31)	.15
6	.15	11	.25	16 (" 36)	.25
7	.20	12	.25	17 (" 53)	.30

Reports 2, 8-12 may also be obtained bound separately in cloth at 25c in addition to the price given above.

Museum bulletins 1887–date. O. *To advance subscribers, $2 a year or 50c a year for those of any one division: (1) geology, including economic geology, general zoology, archeology and mineralogy, (2) paleontology, (3) botany, (4) entomology.*

Bulletins are also found with the annual reports of the museum as follows:

Bulletins	*Report*	*Bulletins*	*Report*	*Bulletins*	*Report*
12–15	48, v. 1	20–25	52, v. 1	35–36	54, v. 2
16–17	50 "	26–31	53 "	37–44	" v. 3
18–19	51 "	32–34	54 "	45–48	" v. 4

The letter and figure in parenthesis after the bulletin number indicate the division and series number. G=geology, EG=economic geology, Z=general zoology, A=archeology, M=mineralogy, P=paleontology, B=botany, E=entomology, Misc=miscellaneous.

Volume 1. *6 nos. $1.50 in cloth*

1 (Z1) Marshall, W: B. Preliminary List of New York Unionidae. 20p. Mar. 1892. *5c.*
2 (B1) Peck, C: H. Contributions to the Botany of the State of New York. 66p. 2pl. May 1887. [*35c*]
3 (EG1) Smock, J: C. Building Stone in the State of New York. 152p. Mar. 1888. *Out of print.*
4 (M1) Nason, F. L. Some New York Minerals and their Localities. 20p. 1pl. Aug. 1888. *5c.*
5 (E1) Lintner, J. A. White Grub of the May Beetle. 32p. il. Nov. 1888. *10c.*
6 (E2) ——— Cut-worms. 36p. il. Nov. 1888. *10c.*

Volume 2. *4 nos.* [*$1.50*] *in cloth*

7 (EG2) Smock, J: C. First Report on the Iron Mines and Iron Ore Districts in New York. 6+70p. map. June 1889. *Out of print.*
8 (B2) Peck, C: H. Boleti of the United States. 96p. Sep. 1889. [*50c*]
9 (Z2) Marshall, W: B. Beaks of Unionidae Inhabiting the Vicinity of Albany, N. Y. 24p. 1pl. Aug. 1890. *10c.*
10 (EG3) Smock, J: C. Building Stone in New York. 210p. map. tab. Sep. 1890. *40c.*

Volume 3. *5 nos.*

11 (EG4) Merrill, F: J. H. Salt and Gypsum Industries in New York. 92p. 12pl. 2 maps, 11 tab. Ap. 1893. *40c.*
12 (EG5) Ries, Heinrich. Clay Industries of New York. 174p. 2pl. map. Mar. 1895. *30c.*
13 (E3) Lintner, J. A. Some Destructive Insects of New York State; San José Scale. 54p. 7pl. Ap. 1895. *15c.*
14 (G1) Kemp, J. F. Geology of Moriah and Westport Townships, Essex Co. N. Y., with notes on the iron mines. 38p. 7pl. 2 maps. Sep. 1895. *10c.*
15 (EG6) Merrill, F: J. H. Mineral Resources of New York. 224p. 2 maps. Sep. 1895. *40c.*

Volume 4

16 (A1) Beauchamp, W: M. Aboriginal Chipped Stone Implements of New York. 86p. 23pl. Oct. 1897. *25c.*
17 (EG7) Merrill, F: J. H. Road Materials and Road Building in New York. 52p. 14pl. 2 maps 34x45, 68x92cm. Oct. 1897. *15c.*
Maps separate *10c each, two for 15c.*
18 (A2) Beauchamp, W: M. Polished Stone Articles used by the New York Aborigines. 104p. 35pl. Nov. 1897. *25c.*
19 (G2) Merrill, F: J. H. Guide to the Study of the Geological Collections of the New York State Museum. 162p. 119pl. map. Nov. 1898. *40c.*

Volume 5

20 (E4) Felt, E. P. Elm-leaf Beetle in New York State. 46p. il. 5pl. June 1898. *5c.*

21 (G3) Kemp, J. F. Geology of the Lake Placid Region. 24p. 1pl. map. Sep. 1898. *5c.*

22 (A3) Beauchamp, W: M. Earthenware of the New York Aborigines. 78p. 33pl. Oct. 1898. *25c.*

23 (E5) Felt, E. P. 14th Report of the State Entomologist 1898. 150p. il. 9pl. Dec. 1898. *20c.*

24 (E6) —— Memorial of the Life and Entomologic Work of J. A. Lintner Ph.D. State Entomologist 1874–98; Index to Entomologist's Reports 1–13. 316p. 1pl. Oct. 1899. *35c.*
Supplement to 14th report of the State entomologist.

25 (B3) Peck, C: H. Report of the State Botanist 1898. 76p. 5pl. Oct. 1899. *Out of print.*

Volume 6

26 (E7) Felt, E. P. Collection, Preservation and Distribution of New York Insects. 36p. il. Ap. 1899. *5c.*

27 (E8) —— Shade-tree Pests in New York State. 26p. il. 5pl. May 1899. *5c.*

28 (B4) Peck, C: H. Plants of North Elba. 206p. map. June 1899. *20c.*

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30 (EG8) Orton, Edward. Petroleum and Natural Gas in New York. 136p. il. 3 maps. Nov. 1899. *15c.*

31 (E9) Felt, E. P. 15th Report of the State Entomologist 1899. 128p. June 1900. *15c.*

Volume 7

32 (A4) Beauchamp, W: M. Aboriginal Occupation of New York. 190p. 16pl. 2 maps. Mar. 1900. *30c.*

33 (Z4) Farr, M. S. Check List of New York Birds. 224p. Ap. 1900. *25c.*

34 (P1) Cumings, E. R. Lower Silurian System of Eastern Montgomery County; Prosser, C: S. Notes on the Stratigraphy of Mohawk Valley and Saratoga County, N. Y. 74p. 10pl. map. May 1900. *15c.*

35 (EG9) Ries, Heinrich. Clays of New York: their Properties and Uses. 456p. 140pl. map. June 1900. *$1, cloth.*

36 (E10) Felt, E. P. 16th Report of the State Entomologist 1900. 118p. 16pl. Mar. 1901. *25c.*

Volume 8

37 (E11) —— Catalogue of Some of the More Important Injurious and Beneficial Insects of New York State. 54p. il. Sep. 1900. *10c.*

38 (Z5) Miller, G. S. jr. Key to the Land Mammals of Northeast North America. 106p. Oct. 1900. *15c.*

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EPHRAIM PORTER FELT State Entomologist

Bulletin 57

ENTOMOLOGY 15

ELM LEAF BEETLE

IN

NEW YORK STATE

Edition 2

BY

EPHRAIM PORTER FELT D.Sc.

ALBANY

UNIVERSITY OF THE STATE OF NEW YORK

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Bulletin 57

ENTOMOLOGY 15

ELM LEAF BEETLE

IN

NEW YORK STATE

PREFACE

This bulletin appeared in June 1898 and as the first edition is practically exhausted, a revision embodying the more essential facts observed since then has been prepared in order to meet the demand for information concerning this deadly enemy of our elms, which is still extending its range in this state. This beetle has abundantly demonstrated its injurious powers in the vicinity of Albany, and in turn the feasibility of controlling it at a very reasonable expense has been proved.

The life history and habits of this beetle have been given somewhat in detail because unless they are thoroughly understood it is very easy to adopt means that are futile or only partially successful. In order to give the bulletin a more practical value, short accounts have also been included of three other insects, which, working with the elm leaf beetle, have aided greatly in ruining many noble elms.

In the portion devoted to remedies prominence has been given to the cost of spraying per tree, the proper apparatus and the time and manner of application. It is surprising to see what mistakes some make in dealing with insects and how methods of no value are clung to. To offset this tendency, two of the more common fallacies are mentioned and their futility shown.

E. P. FELT

Albany N. Y. January 1902

ELM LEAF BEETLE IN NEW YORK STATE

Galerucella luteola Müller

Ord. Coleoptera: Fam. Chrysomelidae

This insect has committed such extensive injuries to elms in cities and villages along the Hudson that it may be regarded as the most important natural enemy of shade trees in this state. Its depredations in this section probably outrank those of all other natural agents combined. Residents of places where this pest has established itself have repeatedly observed the grubs working on their elms and in many instances have seen two, or even three, crops of leaves destroyed in a single season without taking steps for the protection of their trees.

The causes for this condition of affairs are not hard to find, as the majority, if they notice the work of this pest at all, are inclined to trust in Providence and hope that its ravages will not be as severe the next season. Others see the grubs at work on the under side of the leaves or crawling about the tree but not being quite sure of the best method of controlling them, and as any method takes considerable labor, usually make no effort to subdue the pest.

Bad reputation of its family. This beetle is a member of the large, leaf eating family of Chrysomelidae, which comprises a number of our most injurious insects. It includes such well known pests as the asparagus beetle, Crioceris asparagi Linn., the Colorado potato beetle, Doryphora 10-lineata Say, the 12 spotted Diabrotica, D. 12-punctata Oliv. and the striped cucumber beetle, Diabrotica vittata Fabr., all well known insects against which the farmer must wage a more or less perpetual warfare. Another member of this family, the cottonwood leaf beetle, Lina scripta Fabr., recently inflicted serious damage on the large basket industry in the willow growing districts about Syracuse, Rochester and other localities in that part of the state. Judging from the well known records of its allies, we may expect that the elm leaf beetle will continue to be very destructive.

Recent injuries about Albany. The elm leaf beetle was recognized in Albany by the late Dr Lintner about 1892, having

probably made its way here a year or two earlier. Its ravages became more and more serious from that time till 1897, when most of the European elms along our streets were completely defoliated in early summer. The second growth of foliage was seriously injured the same year and some trees had their third set of leaves attacked. It was estimated in 1898 that fully 1000 elms had been killed within the city limits by this pernicious insect and many more would have suffered a similar fate, had it not been for the systematic spraying undertaken then and since continued. See pl. 3 and 4 for representations of the injury caused by this pest.

The record of this insect in Troy has been even worse than in Albany. It probably made its way to that city about the same time that it came here, and up to 1898 practically no effort had been made to check its ravages. At that time probably 1500 elms had been killed within the corporate limits of Troy and since then many others have suffered a similar fate, though not so many have died the last few years on account of the large amount of spraying done in different parts of the city for private parties. Even now it is possible to go into sections of the city and see within two or three blocks 50 to 100 or more dead elms. These are not aged trees that would have died irrespective of attack by insects, but are in most cases trees which a few years ago were as thrifty and vigorous as anyone could desire.

The story of the city of Watervliet has been virtually that of Troy except that less effort has been made to check the pest; also, as a large proportion of the elms in Watervliet were of the American or white variety on which the beetle does not thrive so readily, the destruction was not quite so rapid. It hardly seems possible, however, that fewer than 1500 magnificent trees have been killed or practically ruined by this insect in Watervliet. A brief note published in December 1900 in one of the Albany papers is of value because it gives the testimony of one who probably had little idea of the true cause of the condition complained of. Under Watervliet items was a short paragraph calling attention to the fact that numerous dead trees were a menace to the safety of pedestrians and stating that they were to be found on almost every block in the city. It might further

have very truthfully added that this condition was almost entirely due to the destructive work of the elm leaf beetle.

Practically the same story has been repeated here and there in small towns along the Hudson river valley where this pest has established itself in force; and, unless the insect is checked on its advent into a village, this is likely to be the record whereever it makes its way.

Inaction means death to the elm. The defoliation of a tree in midsummer is a serious injury since the leaves are breathing organs, and if this occurs for successive years even once a season, the early death of the elm may be expected; when it occurs two or even three times in a summer, it is very easy to see that the danger to the tree is increased manyfold.

Such is the record of the elm leaf beetle in this section. The time to control this pest is not after it has become enormously abundant in a city or village and has seriously weakened or nearly destroyed the majority of the elms; the work should be begun at the outset and in the future the insect prevented from establishing itself in large numbers in any uninfested city or village in New York. Village improvement societies and public spirited individuals interested in the welfare of a community where this beetle occurs would do well to undertake at least an educational campaign against it.

It is comparatively useless to hope that in the course of a few years the pest may not be so destructive. It shows a remarkable vigor and prolificacy in our climate. At Washington D. C. it has been known for a long series of years and is still very injurious. In New Jersey, New York city, New Haven Ct. and other localities it has been found necessary to spray the trees with a poisonous mixture in order to avert serious injury. Parasites, diseases of various kinds and predatory enemies seem to have little effect in reducing its numbers.

Distribution. The insect, as stated by Dr Howard, is found over a large part of Europe, but it is abundant and destructive only in the southern portions of Germany and France and in Italy and Austria. The records of the earlier entomologists indicate that the beetle must have made its way to this country about 1834, because in 1838 it was reported as very injurious to elms in Baltimore Md. Its southernmost range has been given

by Dr Howard as Charlotte N. C., and Prof. Webster records having found it north of Salem Mass. It has made its way as far west as Kentucky, at least. Its progress up the Hudson is interesting to follow, indicating as it does, its distribution along the lines of travel. In 1879[1] it was abundant and destructive at Newburg, 12 years later it was reported to this office from Poughkeepsie, in 1890 from Hudson, in 1891 from New Baltimore and in 1892 it had reached Albany and Troy.

It was found at Mechanicville in 1896 by Dr Howard and that same year larvae in considerable numbers were discovered by the writer at Averill park in the town of Sandlake about 7 miles southeast of Troy, the beetles evidently having been transported thither by the numerous electric cars running to that place. The writer also located the pest in 1900 at Hoosick Falls, Rensselaer co. where it had inflicted considerable injury the preceding year, and he found that it had established itself pretty generally in the towns of Stillwater, Schuylerville, Salem and probably Greenwich. Its presence at Salem and its being found at Saratoga in numbers in 1902 indicate a possibility of still farther progress north, though there were reasons for hoping that it would not be very injurious north of Mechanicville, except possibly in an unusual season.

The occurrence of this insect at Oswego, Hastings and Rochester, brought to my notice through Dr Howard, is a much more serious matter. Prof. C. S. Sheldon of the Oswego normal school states that he has examples of it taken at Oswego in 1896, and Prof. M. H. Beckwith of Elmira reports that he has known it to occur for several years in considerable numbers in his locality. It is also extending its range through the Mohawk valley, having recently been found in considerable numbers at Schenectady.

These last records are of very great importance since they show that the insect has already established itself in several widely separated localities in the western portion of the state and we have no good reason for thinking that it will not, in the course of a few years, be as injurious in that section as it has already proved in the Hudson valley.

1 Unfortunately most of these dates indicate only the time when the ravages of the insect were serious enough to attract the attention of someone, and so only approximately the year of its arrival.

It has spread over a large proportion of Connecticut and into Rhode Island. It had made its way up the Connecticut river valley to Springfield by 1891 and to Amherst by 1895. It has now attained a rather general distribution over the eastern portion of Massachusetts, having been recorded by Mr Kirkland from Worcester and towns in that vicinity, Ayer, Groton and places in the eastern and southeastern part of the state. It has also been found in a number of places in western Massachusetts.

The above records indicate most clearly that this pest has not made its way to all portions of New York state where it may be expected to thrive. The climate of the upper austral life zone seems to agree with the insect, judging from its abundance and the number of broods in Albany and vicinity. The area within the state embraced by this zone is rather crudely represented on pl. 2, which was first published in the 11th report on the injurious and other insects of the State of New York for the year 1895. Briefly, it embraces Long and Staten islands, the valley of the Hudson river north about to Saratoga and a large portion of the northwestern and central part of the state adjacent to Lake Ontario and including Oneida, Cayuga and Seneca lakes and neighboring bodies of water. This insect will probably make its way along the lines of travel to most of the cities and larger villages lying within the above limits. The fact of its having become established at localities not yet included within this zone indicates that it may have a somewhat wider range, though climatic conditions will probably prevent its becoming destructive outside this area.

Description. The work of this pest is so striking as to excite the attention of even the most casual observer. The majority have little idea of the appearance of the insect in its various stages and but faint conception of its life history. In order to control it, it must be recognized and its nature understood to a certain extent.

The parent insect may be recognized by aid of the colored figures (pl. 1, fig. 5, 6) though care should be taken not to confound it with the striped cucumber beetle Diabrotica vittata Fabr., which it resembles in a general manner. The elm leaf beetle is about ¼ inch long with the head, thorax and

margin of the wing-covers a reddish yellow. The coal-black eyes and the median spot of the same color on the head are prominent. On the thorax there is a median black spot (not infrequently two triangular ones) of somewhat variable shape and size and a pair of lateral ovoid ones. The median black line of the wing-covers is separated from the broad lateral stripes of the same color by a variable greenish yellow. The elytra or wing-covers are minutely and irregularly punctured and bear a fine pubescence and at the base of each elytron there is an elongated black spot in the middle of the greenish yellow stripe. The markings are usually constant in the adult but the color is quite variable during life and changes more or less after death. Some beetles emerging from winter quarters have the conspicuous greenish yellow stripes of the wing-covers nearly obscured by black. The antennae are a golden yellow with more or less brownish markings. The legs are yellowish with the tibiae and tarsi marked with brown. The under surface of the head and prothorax is yellowish, that of the metathorax and abdomen black.

The orange yellow eggs are deposited in irregular rows side by side, forming clusters of from five to 26 or more on the under surface of the leaf. Several of these are shown natural size in fig. 7. Each egg is somewhat fusiform, attached vertically by its larger end and with the free extremity tapering to a paler, rounded point (pl. 1, fig. 1, 1*a*). Under a powerful lens the fine reticulations of the eggshell are easily seen.

The recently hatched larva (pl. 1, fig. 2) is about $\frac{1}{20}$ inch long, with the head, thoracic shield, numerous tubercles, hairs and legs jet black. The integument between the tubercles is a dark yellow. The tubercles are so large and the hairs so prominent that the prevailing color of the larva at this stage is black. As the larva increases in size and molts, the stiff black hairs become less conspicuous and the yellowish markings more prominent (pl. 1, fig. 3) till the last stage. A full grown larva is about $\frac{1}{2}$ inch long, more flattened than in the earlier stages, with a broad yellowish stripe dorsally and a narrower stripe of the same color on each side, the yellow stripes being separated by broad dark bands thickly set with tubercles bearing short, dark colored hairs. The dorsal yellow stripe is broken on each side

by a subdorsal row of dark tubercles, which increase in size posteriorly. The lateral yellow stripe includes a row of prominent tubercles with dark tips bearing short hairs of the same color. The predominating color of the ventral surface is yellow.

The pupa (pl. 1, fig. 4) is bright orange yellow, about $\frac{1}{5}$ inch long and with a very convex dorsal surface which bears transverse rows of stout, inconspicuous setae.

Life history. In order to control this insect successfully it must be known and its habits understood. Trite though the preceding may appear we have observed men in several places spraying for this pest without accomplishing anything for the simple reason that they did not understand the fundamental principles of fighting insects. In one case the trunk of the tree was sprayed while the grubs were on the leaves; in another paris green and water was used when kerosene emulsion or whale oil soap solution should have been employed.

The beetles pass the winter in attics, sheds, outhouses and various other sheltered places. With the advent of warm weather in the spring they emerge from their retreats and may be found on the walks during the sunny portion of the day or on the windows of houses, vainly trying to escape. Even as early as May 12, numbers of these beetles were to be seen in 1898 on the office windows of the fourth story of the capitol, showing to what a hight they will fly in seeking secure winter quarters. On the appearance of the leaves, the last of April or the early half of May in the latitude of Albany, they fly into the trees and eat irregular holes in the foliage (pl. 1, fig. 9). After feeding some time, and pairing, the orange yellow eggs are deposited on the under surface of the leaves in clusters of about five to 26. The period of oviposition of the overwintered beetles extends from the latter part of May throughout the greater part of June in the vicinity of Albany. The duration of the egg stage in July averages about five days; in cooler weather it may be longer. Feeding and oviposition continue for several weeks in the spring, probably four to six. During this time the beetles consume a large amount of foliage, which is evidently necessary for the development of the eggs, as clusters are laid every day or two till the full complement, which is in the neighborhood of from 431 to 623, is discharged.

As there seems to have been no attempt, at least in this country, to determine the prolificacy of this insect, the following may be of interest. May 31, 1898, two heavy gravid females were isolated, provided with plenty of food, and the eggs removed and counted nearly every day. The results are tabulated below.

Record of eggs deposited by two elm leaf beetles[1]

		FEMALE IN VIAL		FEMALE IN TUMBLER	
DATE		CLUSTERS OF	TOTAL	CLUSTERS OF	TOTAL
June	1	(2)	29	(4)	42
	2	....	....	....	....
	3	9, 9, 14	32	18	18
	4	....	....	....	....
	5	....	....	....	....
	6	18	18	26, 21	47
	7	....	....	....	....
	8	15	15	4, 26	30
	8 (2 p. m.)	20	20	....	....
	9	....	....	27	27
	10	20	20	(3 p. m.) 3, 31	34
	11	23	23	....	....
	12	....	....	....	....
	13	11, 13	24	3, 7, 8, 11, 15, 19	63
	14	31	31	....	....
	15	16, 5	21	14, 27	41
	16	28	28	30	30
	17	....	....	32	32
	18 (absent)	....	....	....	....
	19	26, 30	56	10, 26	36
	20	2, 6	8	36	36
	21	3, 18	21	6, 25	31
	22	2, 20	22	4, 31	35
	23	27	27	1, 2, 11, 7, 13	34
	24	....	....	....	....
	25	....	....	....	....
	26	....	....	....	....
	27	5, 7, 9, 15	36	13, 21, 32	66
	28 (beetle dead)	....	....	(beetle dead) 4, 17	21
	Totals	....	431	....	623

1 The examinations were made as a rule between 8.30 and 9 a. m. though occasionally, when eggs were seen in the afternoon, they were recorded at the time indicated in the table. The dates in italics fell on Sunday and usually no observations were made then.

The above records have a very vital bearing on remedial measures. From June 1 to 11 from 15 to 47 eggs were generally deposited every other day. The 12th being Sunday the beetles were not attended, but two or more clusters being found with each on the following morning, probably one or more were deposited on Sunday.

The records show that from June 12 or 13 to 23 there was a marked increase in the number of eggs, eight to over 40 being as a rule deposited daily. The record of the beetle confined in the vial indicates a discrepancy greater than the facts warrant. It was impossible to attend the insects on the 18th, so it appears as though two days had been skipped by one beetle and one day by the other, whereas it is probable that there was but a day that the beetle in the vial did not deposit eggs, and the record of the other was probably unbroken, eggs being deposited daily.

During this short period of 10 or 11 days—June 12 or 13 to 23—there were deposited over half the total number of eggs produced during the 28 days the record was kept, the figures being 330 and 338 respectively or an average of over 21 and 30 eggs a day. The average number deposited during the first 11 days of the month are 14 and 18 respectively, which shows that there was an increase in the daily average of one half or more in the case of each beetle after June 11. Those deposited after the 25th were apparently the last efforts of the insects to provide for the perpetuity of their kind, though the quality of the eggs had not deteriorated so far as observable.

The continued oviposition and the prolificacy of the beetles is strikingly shown in this record. They were abroad in numbers by May 12, 1898, and oviposition began about the 25th, so the record of these two individuals is probably lower than the normal as they may have deposited several clusters of eggs before being captured. They were both supplied with fresh leaves from day to day and the eggs removed and counted as soon as detected. The female producing the smaller number of eggs was confined in a small, corked vial, while the other enjoyed the freedom of a jelly tumbler. The difference in condi-

tions undoubtedly had some influence on egg production and the protection from unfavorable weather conditions enabled the beetles to approximate the maximum quota of eggs. The record is of great value since it shows clearly how long oviposition may be continued by a single individual, and shows that if the adult beetles can be killed by thorough spraying any time before this period of greatest reproductive activity, which was about June 11 in 1898, the deposition of a very large number of eggs can be prevented, with correspondingly less danger from the grubs or larvae.

The grubs emerge from the eggs early in June or about five or six days after oviposition, and soon begin to feed on the under surface of the leaves, producing the familiar skeletonized appearance well represented on pl. 1, fig. 8 and pl. 7, fig. 1. This is caused by their eating the softer under part, the upper epidermis and the veins being left. The result of their feeding is so characteristic that it is easy to detect their presence by the semitransparent places in partly eaten leaves and by the skeletonized appearance of the foliage which has been more severely attacked.

The grubs complete their growth in 15 to 20 days in summer (in cooler weather the time may be greatly extended), become restless, forsake the leaves and descend the limbs and trunks to a greater or less extent, seeking proper shelter for pupation. In warm July weather seven days are passed in this state, in September the time is extended to 12 days and in October to 24. The descent of the larvae of the first brood usually occurs in Albany the latter part of June; in 1896 some were observed descending June 19, and beetles of the second brood were taken June 30. The oviposition of the second brood of beetles begins about the middle of July. From that date till late in the autumn it is possible to find the eggs of this insect most of the time in some part of the city. The beetles are naturally attracted by a fresh growth of foliage and it is on the trees throwing out a second or a third crop of leaves or on those not attacked earlier in the season that the eggs of later generations

are found most abundantly. Most of the second brood of larvae complete their growth about the middle of August, becoming adults the latter part of the month. If there is an abundant food supply a partial third generation may be produced. In 1896 numerous eggs were found on elms in Troy the first part of September. This was probably the case in Albany also, as indicated by the large numbers of full grown larvae descending near the middle of October certain Scotch elms which had been practically uninjured in the early part of the season.

This latter occurrence shows most conclusively that the larvae are able to develop on old leaves. The persistent breeding of the insect late in the autumn is shown by the presence of full grown larvae on elm trunks October 31 and by the finding of living pupae on November 7 in 1896, and in 1897 on the still later date, November 16.

Number of generations. The detailed observations of 1896 to 1898 have established beyond question the possibility of two well marked generations annually and the occurrence under favorable conditions of an incomplete third brood at both Albany and Troy. In these two cities the insect has continued breeding as long as the elms afforded sustenance. There is every reason for believing the same to be true in adjacent cities and villages. This is the more remarkable since Dr Smith records but one brood a year, or one and a partial second, at New Brunswick N. J., about 150 miles to the south. As is well known, most insects are more destructive soon after their introduction than in later years. This may be accounted for by the fact that in time native parasites, diseases and other natural checks gradually assert their power on new comers. An insect's freedom from natural enemies might have some effect on its prolificacy, and possibly on the number of generations. It will not only be of interest but of great practical importance to ascertain by observations whether this beetle continues to produce two or three generations yearly in this latitude.

Habits of beetles and larvae. A knowledge of certain habits of this insect are of great value in controlling it. Its hibernation

affords no vulnerable point as the beetles are then too scattered to admit of effective work against them. They feed on the young leaves in the spring for two or three weeks and when abundant may cause considerable injury. The irregular round holes in the foliage (pl. 1, fig. 9 and pl. 7, fig. 2) are an indication of the presence of the beetles, and the amount of injury gives some idea of their abundance. Under exceptional circumstances they may eat the under surface of the leaves, refusing the veins and tough upper epidermis. This is only when the foliage is unusually hard and dry.

One habit of much importance which the adult insect possesses is its disinclination to fly a great distance. Its instinct to remain near one spot is so strong that it spreads very slowly indeed. This is clearly shown in its taking seven years to make its way in numbers from the point where it established itself first in this city to Washington park, a distance of less than 1½ miles. We have repeatedly seen European elms badly defoliated and within 50 feet others of the same species would be hardly affected. In three years (1895-98) it made its way along certain rows of European elms in Albany at the rate of about a block a year.

The larvae are very rarely found on the upper part of the leaf; they appear on the under surface and feed there almost exclusively. It is also evident that in most cases trees are attacked near the top, probably because the foliage of the upper portion is more tender and clean. This is well shown on pl. 3, where the dead tips are high, showing conclusively the preference the beetles have for the younger leaves.

The larvae forsake the leaves after attaining their growth and may be found crawling along the limbs and trunk. If the tree has comparatively smooth bark, a far greater portion make their way to the ground in search of proper shelter while passing through the pupa stage, than if it has a rough bark, which affords numerous secure crevices in which the final changes may be effected. At this time the trunks of infested trees present an interesting sight as thousands of the grubs

crawl up and down the shaggy bark. Occasionally their numbers are so great as to give a distinct character to the surface they are moving over, presenting a peculiar grayish yellow mass of motion enlivened here and there with an orange yellow pupa. A few days later the pupae are more numerous on the trunk and around the base of the tree and adjacent shelter, where they may sometimes be found in golden layers nearly an inch deep, interspersed here and there with a dark larva. Many larvae do not descend the older trees but take refuge in the crevices of the bark, or, if there are overhanging limbs, may drop in numbers from the tips of the branches. Many are content to transform in the gutters, others seek shelter in the crevices of the sidewalks and large numbers cross wide spaces and pile themselves up against a wall or a fence or around any sheltering bush or weed.

SPECIES OF ELMS ATTACKED

It will be observed in most localities that the American elm, Ulmus americana, is comparatively exempt from the attacks of this insect. Sometimes the beetles will make their way from adjacent European elms and seriously injure the American species and, after they have once become established, the but partially migratory habit of the beetle insures attack for a few successive seasons at least. The English elm, Ulmus campestris, and the Scotch elm, Ulmus montana, usually suffer most seriously, while our native species are but little affected. This was very noticeable in Troy and Lansingburg. European elms are numerous in the former place and the work of the elm leaf beetle is conspicuous over the greater part of the city, but as one proceeds northward into Lansingburg American elms abound almost to the exclusion of the foreign species and evidences of the pest are comparatively rare. Again, in 1895 the American elms of Albany showed very little injury by the insect. The next year trees here and there gave evidence of a serious attack and in 1897 a much larger number of the American elms was seriously injured than in the preceding year. The numerous American elms in Water-

vliet have been very severely injured, though the relatively few European elms suffered more.

No species of elm grown in this country is exempt from attack though there is considerable variation in the degree of injury inflicted on the different kinds. The relative liability to attack is apparently a variable quantity in different localities. According to Dr Howard's observations, the American elm suffers more from the insect than does the Scotch, the English species being the favorite, while in both Albany and Troy the injuries to the English and Scotch varieties were about equal, the latter suffering more in many instances, while the American elm was eaten to a much less degree.

AN ASSOCIATED INSECT

The elms, particularly the European species, in Albany, Troy and other places along the Hudson river are most unfortunate in suffering from the attacks of another imported insect known as the elm tree bark louse, Gossyparia ulmi Geoff. This was first discovered in this country at Rye, Westchester co. N. Y. in 1884, on the nursery stock of Mr Charles Fremd. It is now known to occur in a number of localities in the Hudson valley, being generally distributed over Albany, Troy and adjacent towns, and ranging north to Greenwich. It has been received by the writer from Ogdensburg, St Lawrence co. It has also become established in the vicinity of Boston and at Amherst Mass. and Burlington Vt. Other recorded localities are Washington D. C., Michigan agricultural college, Carson City Nev. and Palo Alto Cal.

Injuries and characteristics. The injurious nature of this bark louse in our latitude has been abundantly demonstrated the past few years in conjunction with the work of the elm leaf beetle. The affected trees are easily recognized in midsummer by their blackened appearance, which is caused by a growth of the fungus Coniothecium saccharinum Peck in the honey dew covering the foliage, the limbs and the ground beneath. The minute drops of the secretion may easily be seen in sunlight falling in showers from the clusters of insects,

giving an idea of what a drain this species must be on a tree's vitality. The limbs which have harbored the bark louse for a few years begin to die, the tree itself shows signs of weakness, and when it is attacked by both the elm leaf beetle and the bark louse, its destruction follows in a few years.

Description and life history. The adult females are rather conspicuous during April, May and June. They may be found on the under sides of the smaller branches, frequently clustered in masses and appearing not unlike certain lichens. Each at this time is about $\frac{1}{16}$ inch long, oval in outline, with the extremities slightly pointed, and if crushed causes a reddish stain from the contained ova. The body is surrounded by a mass of white, woolly secretion and the segmentation is also indicated by the same substance, as shown in pl. 8, fig. 1. The minute yellow young make their appearance early in July and soon settle for a time on the greener twigs and along the principal veins of the leaves. Occasionally a greenish twig will be almost yellow on account of the large number of young settled on it. In the autumn the back of the partly grown bark louse is covered with spiny processes which excrete a protective, whitish waxy matter. Most of the insects forsake the leaves at this time and settle for the winter in crevices of the bark. The females molt for the last time early in April, and the males spin their oval cocoons (pl. 8, fig. 2). The delicate, four winged reddish male is rarely seen, though of particular interest from its presenting a partially developed form known as the pseudimago. The latter was present in large numbers May 10, 1900, while the perfect males were not found till the 21st.

Means of distribution. As the slender males only are winged, the insect is dependent largely on various outside agencies for its distribution. It has most probably been carried to Nevada, California and other distant localities on infested nursery stock, but this does not explain its general occurrence in such cities as Albany and Troy. Its distribution in these two places, at least, appears to have been largely effected by the aid of the English sparrow and other birds; the active young can easily

crawl on the foot of a bird and thus be transported from one tree to another. Other insects may also to a certain extent transport them and some, falling with the leaves, might successfully make their way up another tree; the chances, however, are against the latter method.

SECONDARY ATTACKS BY INSECTS

It is well known to students of nature that an enfeebled tree apparently invites attack by certain insects which seem to find

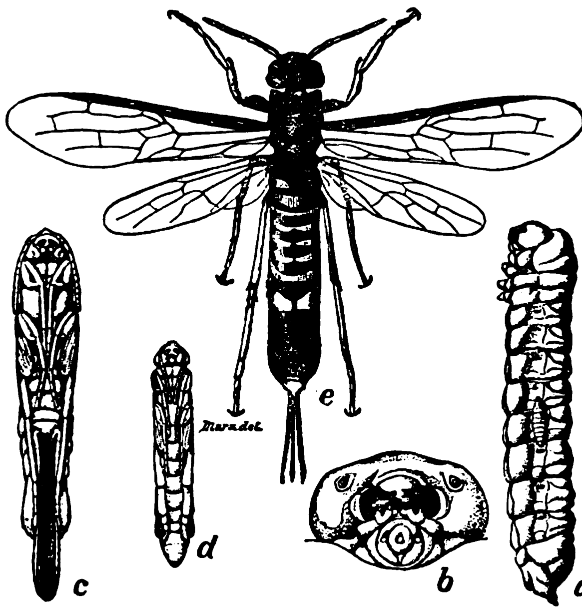

Fig. 1 Tremex columba: *a*, larva showing the Thalessa larva fastened to its side; *b*, head of larva; *c*, pupa of female; *d*, male pupa; *e*, adult female; all slightly enlarged. (After Riley, *Insect life*, v. 1, fig. 39)

in the unhealthy tissues conditions peculiarly fitted for their development. The ravages of the elm leaf beetle have encouraged certain of these pests to a marked degree. One of the most common and injurious is known as the pigeon Tremex, Tremex columba Linn. This insect is a magnificent four winged fly about 2 inches long, with a wing spread of 2½ inches and a prominent horn at the extremity of the abdomen from which it gets the common name of horn tail. It may be recog-

nized by its cylindric dark brown abdomen with yellow markings as represented in fig. 1.

The female deposits her eggs in the trunks of sickly trees, where the larvae run large cylindric burrows. Many elms in both Albany and Troy show numerous holes caused in this way. This borer has a deadly parasite in the lunate long sting, Thalessa lunator Fabr. This beneficial insect is of great aid in keeping the Tremex under control. The remains of 13 ovipositors were found by the writer in the trunk of one small elm. In their efforts to reach the numerous borers in the tree, the females had driven their long ovipositors so far into the wood that they were unable to withdraw them.

Another insect which infests debilitated elms is known as the elm borer, Saperda tridentata Olivier. The larvae of this beetle run their burrows under the bark and in the sapwood of the trunk, not many penetrating to a greater depth than an inch. Their burrows frequently become so numerous as to girdle trees two or three feet in diameter. An infested elm may be recognized by the patches of unhealthy bark; in case of a bad infestation large pieces become loose and scale off easily. The beetle is usually less than ½ inch long, and of a dull slate color, with the thorax and wing-covers margined with dull orange (fig. 2).

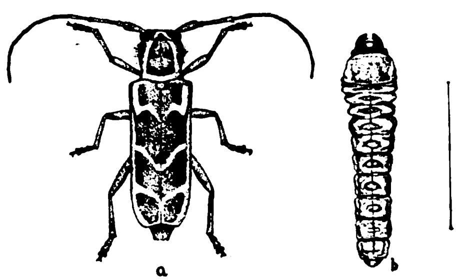

Fig. 2 Saperda tridentata (twice natural size)

NATURAL ENEMIES OF ELM LEAF BEETLE

The natural checks serving so well to keep thousands of insects under control which otherwise would be very destructive, are unable to reduce the numbers of this beetle to a relatively harmless figure. One of the more important natural agents is

the fungus Sporotrichum entomophilum Peck, which has been observed developing on many beetles in this city. Like the disease of the chinch bug caused by the allied fungus, Sporotrichum globuliferum Speg., the one attacking the elm leaf beetle requires moist atmosphere for its development. Beetles in close breeding jars, under the bark of trees or in similar damp places succumb readily to the disease. Climatic conditions are not ordinarily favorable to the rapid growth of this fungus, so it has a relatively slight value as a natural check on the elm leaf beetle.

Several insects are known to prey on this pest, its pupa or its larva. Three beetles, Platynus punctiformis Say, Quedius molochinus Grav. and Chauliognathus marginatus Fabr., feed on this species as recorded by Riley. A fly, Cyrtoneura stabulans Fall., destroys many pupae in Washington. In this latitude the half grown larva of Podisus spinosus Dallas has been observed with an elm leaf beetle grub on its extended beak, and it probably preys extensively on the larvae, since in Washington all stages are known to attack it. Mr Kirkland has recorded two other species, Podisus serieventris Uhler and P. placidus Uhler as preying on this pest. He also found Stiretrus anchorago Fabr. feeding upon the larvae. A small capsid, Camptobrochis grandis Uhler, sucks the eggs. Larvae of lacewing flies, also called aphis lions, are frequently found on leaves with the young of the elm leaf beetle, and are reported by Riley to feed on both eggs and larvae. Mites have been observed by the writer near egg clusters that had suffered injury. This insect finds an enemy in the southern portion of its range in the praying Mantis, Stagmomantis carolina Linn. It is very probable that the European praying Mantis, Mantis religiosa Linn., recently established in a number of localities in the state through the efforts of the writer, will also prey on this injurious beetle.

Though we have seen nothing of the kind in this vicinity, one gentleman affirms most positively that the English sparrow

feeds on the elm leaf beetle larvae, having repeatedly observed it picking them off the trunks of the trees. If the sparrow has this habit, it offsets to a certain extent its many bad features.

REMEDIES

The most satisfactory method of controlling this insect is by poisoning the foliage. The objection heretofore urged against this means has been the expense, and it still applies to a certain extent in the case of the private individual with but few trees to care for. Aside from the cost of the necessary apparatus, the operation of spraying even large shade trees is not so expensive as is commonly supposed; and valuable results may be obtained with a comparatively inexpensive outfit, though the cost for each tree may be increased.

Cost of spraying elms. We have taken some pains to ascertain the precise cost of spraying a tree in the hope of encouraging those to whom the expense seems a serious item. It is pleasant to record that it is much lower than had been supposed previous to the time this bulletin was originally prepared; more recent data confirm the fact. Dr Smith, of the New Jersey agricultural experiment station, kindly supplied the following data in 1898. The elms on the college campus at New Brunswick are 50 to 75 feet high and were sprayed at odd times by the janitors, about an hour being required by two with force pump, tank and ladders to treat one tree. The poison necessary for each spraying was worth about 6c. It will thus be seen that the cost for each tree would be between 36c and 56c, varying with the price of labor. In New Brunswick the trees were sprayed at a contract price of $1 for the season, the understanding being that they were to receive three treatments if necessary. The contractor prepared the outfit, furnished the material, did the spraying at the price mentioned and had a neat margin remaining.

The cost of spraying elms in Albany in 1898, aside from wear and tear of the apparatus, was about 15c a tree for each spraying. This average was based on one or two days work and probably would not hold for the season. It is very likely that it would have paid to give each tree a little more time, which

would have brought the average cost up somewhat. The elms of Albany range from 20 to about 70 feet in hight, though most of them are over 50.

The average cost of one spraying in Albany in 1900 was about 22c a tree. The spraying was done with an apparatus, to be described later, and under civil service regulations, which require men to work but eight hours a day. Two power spraying outfits under one foreman's direction constituted the force. It would be possible in private work to reduce the force somewhat and have one man do duty both as motorman and driver. A little more selection could also be exercised and possibly more efficient men secured than can usually be obtained under civil service regulations.

Mr H. W. Gordinier of Troy found that in contract work in the village of Lansingburg, where he sprayed all the trees, the average cost a tree for each spraying was 23c. This figure, however, was raised considerably in his work in Troy where the trees were sprayed at the expense of private parties and there was necessarily much running hither and thither; under these conditions it ranged from 50c to 60c a tree, the cost depending on the size and the number in one locality.

The saving in cost shown by the above figures, not to mention the greater benefit to the public, particularly in the poorer sections of a city where shade trees are most needed and where they are usually neglected, is a strong argument in favor of such spraying operations being done under village and municipal authorities. The more general and thorough the work, the more satisfactory the results.

Proper apparatus. In order to do this work successfully one must possess a force pump capable of throwing a stream some distance, a number of feet of hose and a nozzle that will discharge a rather fine spray. There must also be something to hold the poisonous mixture and a ladder facilitates the work of application greatly.

One of the best arrangements for hand work is most probably found in the spraying outfit on wheels so that it can be readily

moved from place to place (pl. 6). In most cases this takes the form of a box or barrel to which a force pump is firmly attached, and is either provided with wheels or designed to be placed in a wagon. It is necessary to have 25 to 50 or more feet of ¼ or ½ inch hose when spraying tall trees, while the addition of a 10 to 25 foot metal extension adds materially to the value of the apparatus. It is also necessary to have a good nozzle that will not clog, but will produce a fine spray and can be quickly adjusted to throw a coarse spray some distance if necessary. Such an outfit is of great service to any individual having considerable spraying to do and it could undoubtedly be used to advantage by those desiring to make a business of spraying in a small way, as for example the treating of trees here and there for those in cities wishing their trees sprayed and not willing to purchase the necessary apparatus.

In the extended work against this insect conducted by cities and villages it is desirable to have apparatus that will admit of more rapid work. This has led to the refitting of retired fire engines and the designing of more or less cumbersome outfits for the purpose. In all cases these makeshifts have been successful, though they are not so satisfactory in operation as those specially fitted for the purpose. One of the best forms of apparatus yet designed for spraying trees is that constructed under the direction of Dr E. B. Southwick, entomologist of the department of public parks of the city of New York. This is the form used in Albany. The whole outfit is represented on pl. 5. It consists of a Daimler gasoline motor operating a Gould force pump. The motor and pump, weighing but 300 pounds, can be placed in the bottom of a spring wagon along with the 100 gallon tank containing the poisonous mixture. This motor has the advantage of being almost noiseless in operation and is scarcely noticed by passing horses. It is very inexpensive to operate, as a gallon of gasoline is sufficient for a day, and it requires so little attention that a tyro can run it. The smallest size Gould three piston pump is the one used with the motor, though Dr Southwick now recommends a larger one

in order to utilize the power more fully. A complete power spraying outfit, aside from horse and wagon, should not cost over $500, the price naturally varying with market conditions and quality of materials used. Four lines of hose can easily be supplied though in most places in Albany not more than two can be used to advantage.

Some other apparatus in addition to that usually supplied with spraying outfits is necessary. Several ladders or some convenient arrangement for getting up into trees is almost essential unless the spraying wagon has one of the elevating platforms such as are used by electric car companies on repair outfits. Two power spraying outfits constructed for the village of Saratoga in 1899 were provided with these elevating towers and these were found to be very effective and economical. The cost of spraying for the forest tent caterpillar which, by the way, need not be done so carefully as for the elm leaf beetle, was but 17¼c a tree and considerable of this saving was attributed to the elevating towers. In this instance 5667 large maple trees were sprayed and practically all in the village were treated, thus enabling the operators to save time in every possible manner.

Time and manner of spraying. Though it is easy to state the proper time to spray, in many cases it is exceedingly difficult to have the recommendations properly carried out. The beetles feed in the early spring on the young foliage for a considerable time before any eggs are developed and eat for a day or two between the deposition of the clusters. It therefore follows that if the partly unfolded leaves are sprayed at this time the beetles can be killed and the production of eggs prevented to a large extent. This is very desirable, for if at all numerous the beetles injure the foliage considerably. A number of arsenical poisons can be used in the control of this insect with very good results but the experiences of the last four years have demonstrated the great superiority of arsenate of lead for this work. This is a preparation made by combining acetate of lead and arsenate of soda. It may be prepared as follows: dissolve 11

ounces of acetate of lead in four quarts of water in a wooden pail and four ounces of arsenate of soda (50% purity) in two quarts of water in another wooden pail. As the acetate of lead dissolves rather slowly in cold water the process can be hastened by using hot water. Pour the solutions in enough water to make 80 gallons.

It was at first advised to prepare this poison in the manner indicated above but the difficulty of getting chemicals of the same grade of purity year after year and the ease with which dealers in these substances may prepare this insecticide, has led to the introduction of several brands of arsenate of lead in the prepared paste form. These preparations have been found more convenient than the homemade article and generally speaking their use is advisable. The crystalline arsenate of lead is not in proper condition to use as an insecticide and therefore it is necessary to get the specially prepared article.

The value of arsenate of lead over other poisons lies in its adhesiveness to the foliage—it frequently remains on the leaves nearly an entire season in spite of many rains—and in the fact that it can be applied in almost any amount without danger of injuring even the most delicate leaves. Paris green, london purple and similar arsenical poisons operate more quickly than arsenate of lead but they are also readily washed off by rains, and in the case of an insect like the elm leaf beetle, which feeds for an extended period, it is much better to apply the more adhesive preparation even though the cost be somewhat greater. The necessary amount of prepared arsenate of lead is usually stated on the package and it varies somewhat with the method of manufacture.

The first spraying, as stated above, should be given as soon as the leaves commence to develop and usually it will be necessary to repeat the treatment at the time the young larvae begin their work, though after the insect has once been brought well under control in a locality, possibly a single thorough spraying each year for the beetles may be sufficient. Experience has shown that in a locality where all the elms are thor-

oughly sprayed it may not be necessary to treat them again for two years.

The second spraying should occur at the time the young are beginning to hatch, which in this latitude is about the first week in June. The poison should be applied to the under surface of the leaves. This is because the larvae feed only very exceptionally on the upper surface of the foliage or even break the upper epidermis. Consequently it is impossible to poison them unless the insecticide be thrown on the under surface. The larvae succumb to the poison more readily than the beetles and it is therefore not necessary to use so concentrated a mixture in the later sprayings.

The necessity for subsequent sprayings depends largely on the manner in which the previous work has been done. Much depends on the man who holds the nozzle, even though he be under the eye of one who understands the business. The mixture should be applied evenly in a rather fine spray and so far as possible to every leaf. If the poison be applied thoroughly and at the right time, two sprayings should be ample to keep the beetle under control. Otherwise it may be necessary to spray for the second and even the third brood. The proper time for later arsenical sprayings must be determined by observation. The spraying for the second brood should be done in Albany and Troy about the latter half of July.

A PALLIATIVE MEASURE

It frequently occurs that for some reason spraying with poison can not be resorted to readily. The habits of this insect are such that at certain times large numbers can be destroyed with little labor, as has been pointed out year after year. But it is well to understand that such a measure is not a remedy in the true sense of the word; it is simply a palliative. Everyone interested in the welfare of his shade trees should at least destroy the thousands of larvae and pupae on the trunks or around the base of infested elms. If the base of the trees, their surroundings and other adjacent shelters be thoroughly drenched with boiling water or sprayed with kerosene, kero-

sene emulsion or some similar preparation, thousands of these insects can be killed. As it requires six or seven days for the larvae to pass through the pupal stage to beetles, this operation need not be performed oftener than once in five days to insure the destruction of all that have pupated within reach of such a measure. The nearly simultaneous descent of the grubs is very favorable to this way of checking the insect and reduces the necessary labor to a minimum. To make this method more effective, it has been recommended to inclose a limited smooth area around each infested tree, preferably cemented, boards being arranged to prevent the larvae from escaping to shelters where they could less easily be destroyed. Such an inclosure might be advisable around small trees with relatively smooth bark and no overhanging limbs, but it would hardly pay to treat larger trees thus on account of the large number of larvae pupating in the crevices of the bark or dropping from the tips of overhanging limbs. The great objection to fighting the insect at this stage is that the injury has already been accomplished, but to do even this is much better than to allow it to go on unchecked, because it must have some influence on the future abundance of the beetle. The destruction of larvae and pupae around the base of the trunk may well be undertaken to supplement the spraying and thus secure the destruction of the largest possible number of the insects.

USELESS MEASURES

Though the life history of this beetle is well known, at least to entomologists, it is surprising how people will cling to some false idea, gained they know not where, of the method of fighting this or some other insect. One of the most persistent of these fallacies is that cotton placed around the trunk will protect a tree from the elm leaf beetle. Under certain conditions a band of cotton, tar or other substance will protect trees from some insects, but never from the elm leaf beetle. It should be understood that the parent insect flies up into the tree, feeds for a time and then lays the eggs from which the grubs emerge to commence their injurious work. The band can not have the

slightest influence in protecting the elm. It is only when the grubs are full grown that they are found on the trunks and then only on their way to seek shelter on the ground during pupation. If a band of any kind blocks the way to the ground they may transform on the tree or even in the meshes of the cotton band and fly away later. If the band is of tar or sticky fly paper large numbers of the grubs may be caught on its surface, but there will hardly be enough to pay for the trouble incurred.

Another so called remedy for the elm leaf beetle consists in boring a hole to some depth in the trunk, nearly filling it with sulfur or other preparation and then inserting a plug. This method of treatment or some modification of it is being brought forward every few years as one of the "sure cures." The destruction accomplished by the elm leaf beetle has encouraged at least one unscrupulous firm to advertise a modification of this method as a sure cure. The Elm inoculation company in 1895 treated many elms in Connecticut and 150 for one man in Westchester county, N. Y., charging 50c or more a tree. Chemical analysis showed their secret preparation to be nothing of value. This or any similar treatment may well be regarded suspiciously by any would-be investor. It is hardly necessary to add that such a remedy has no basis in scientific fact and similar recommendations should not be heeded unless they come through such channels that their authenticity can not be doubted.

REMEDIES FOR ASSOCIATED INSECTS

The elm bark louse belongs to Hemiptera, that large order of insects which take food only by suction through a fine proboscis from the underlying tissues. It is easily seen therefore that a poison applied externally to the tree, as for example paris green, would have no effect on this pest. The best remedy is one of the contact insecticides, preferably kerosene emulsion or whale oil soap solution. This should be sprayed on the under surface of infested limbs and foliage when the tender young are appearing. Kerosene emulsion may be prepared by dissolving a half pound of hard soap in a gallon of

boiling water; while yet hot add two gallons of kerosene and emulsify thoroughly by passing it rapidly through a force pump till it is white and has a creamy consistency. For the young, one part of this emulsion to 10 parts of water should be effective. Whale oil soap solution may be used in the same manner, a pound of the soap being dissolved in four gallons of water. These preparations could be applied in the autumn after the dropping of the leaves, but in this case the solutions should be about four times as strong. Small trees may be cleaned with a stiff brush, which might be made more effective by dipping it in one of the above solutions from time to time.

Preventive measures against borers are of much more importance than any remedies that can be applied. The trees should be kept in as vigorous a condition as possible and careful watch maintained for the first signs of boring, indicated by the detached grains of wood popularly termed "sawdust." When indications of their presence are found the larvae should be dug out if possible. A badly infested tree should be cut down and burned to prevent the insects from developing and the adults from making their way to other trees.

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EXPLANATION OF PLATES

PLATE 1[1]

Elm leaf beetle

FIG. Galerucella luteola Müller

1 Cluster of eggs, much enlarged
1*a* Side view of single egg, still more enlarged
2 Recently hatched larva or grub, much enlarged
3 Full grown larva or grub, much enlarged
4 Pupa, much enlarged
5 Overwintered beetle, much enlarged
6 Fresh, brightly colored beetle, much enlarged
7 Leaf showing eating of larvae or grubs and a few holes eaten by beetles, eggs in clusters, cast larval skins and full grown larvae, natural size

[1] Executed from nature, under the author's direction, by Mr L. H. Joutel of New York city, and reproduced from the 5th report of the commissioners of fisheries, game and forests through the courtesy of the commissioners.

FIG.

8 Leaf nearly skeletonized by grubs or larvae and on it two cast larval skins, natural size

9 Leaf showing holes eaten by beetles, natural size

PLATE 2

Upper austral life zone in New York state, which is the area likely to become infested by the elm leaf beetle

PLATE 3

Work of elm leaf beetle on Elm street, Albany, taken 15 June 1898.

PLATE 4

Work of elm leaf beetle on Jacob street, Troy, taken 15 June 1898.

PLATE 5

Power spraying outfit at work in Albany, taken 15 June 1898

PLATE 6

Hand spraying outfit at work in Albany, taken 15 June 1898

PLATE 7

1 Work of elm leaf beetle larvae, showing characteristic skeletonizing

2 Work of elm leaf beetles, showing characteristic holes (original)

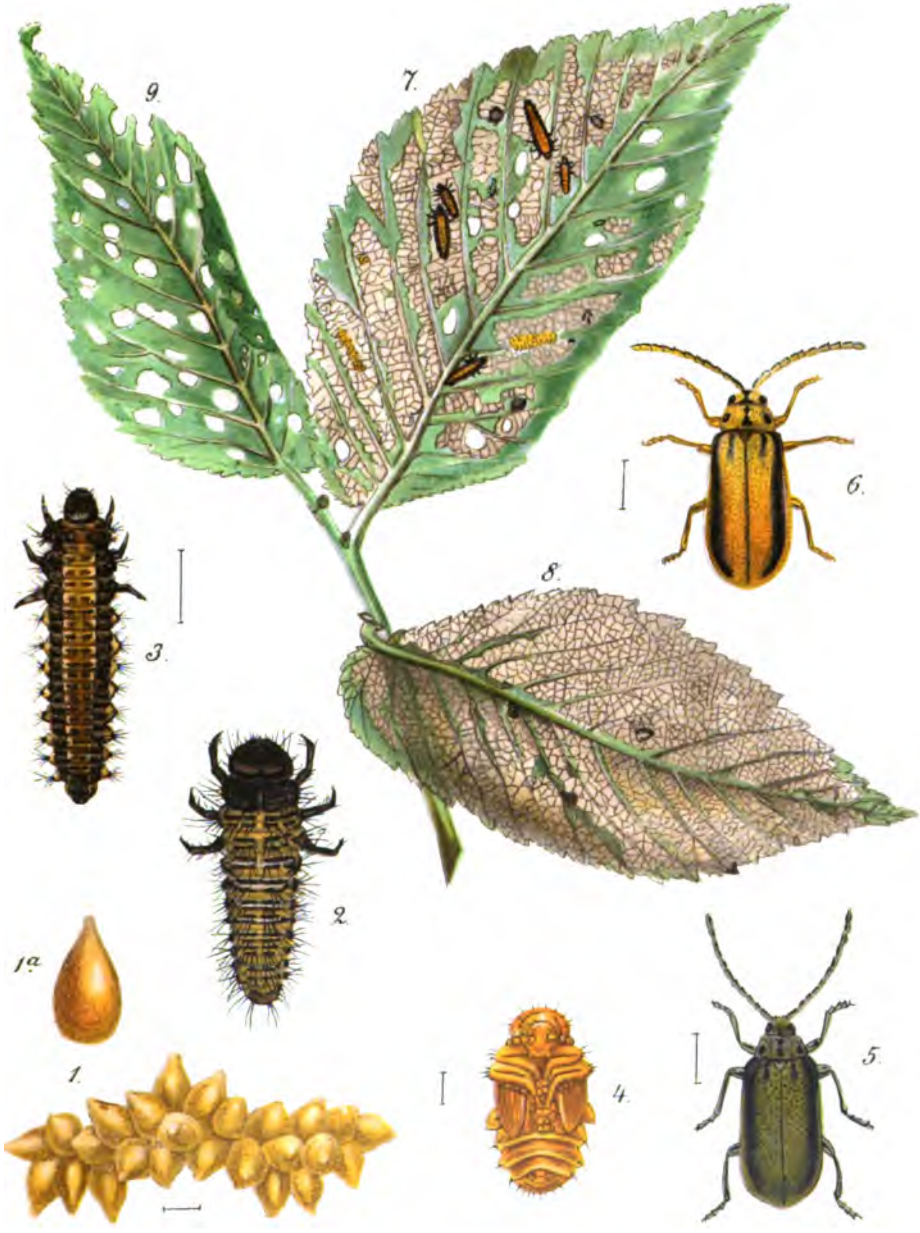
PLATE 8

Gossyparia ulmi Geoff.

1 Females, slightly enlarged

2 Cocoons of males, three times natural size

PLATE 1

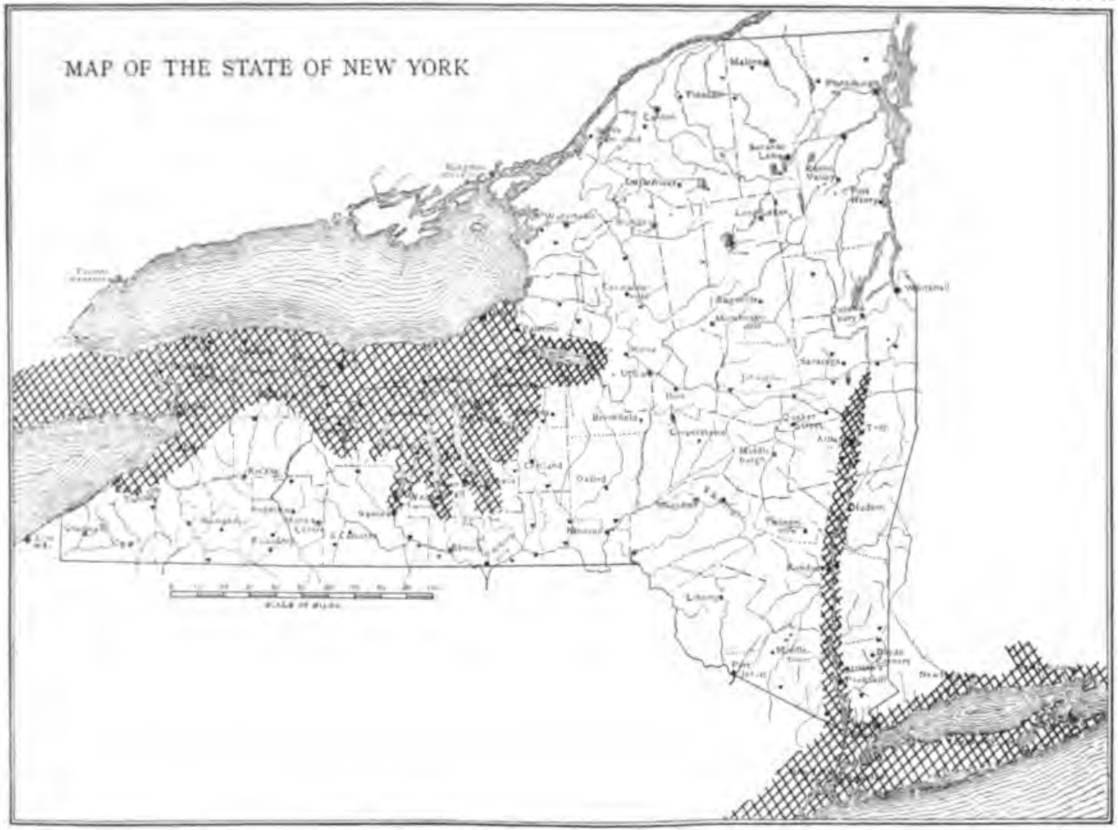


L. H. Joutel, 1900

ELM LEAF BEETLE

James B. Lyon, State Printer

(Reprint from 5th report of commissioners of fisheries, game and forests.)



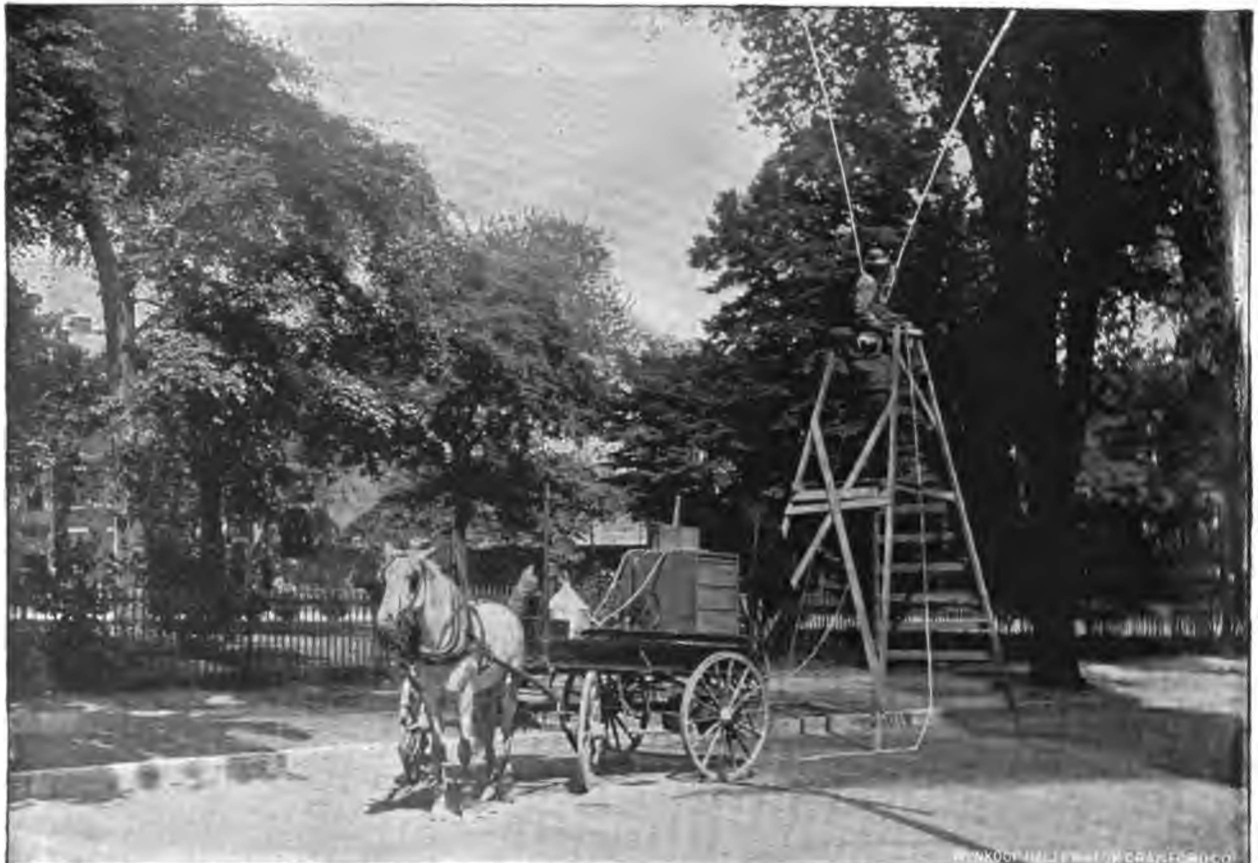
Upper austral life zone in New York state, which is the area likely to become infested by the elm leaf beetle (After Lintner)

Work of elm leaf beetle on Elm street, Albany   Photo 15 June 1898

Plate 4

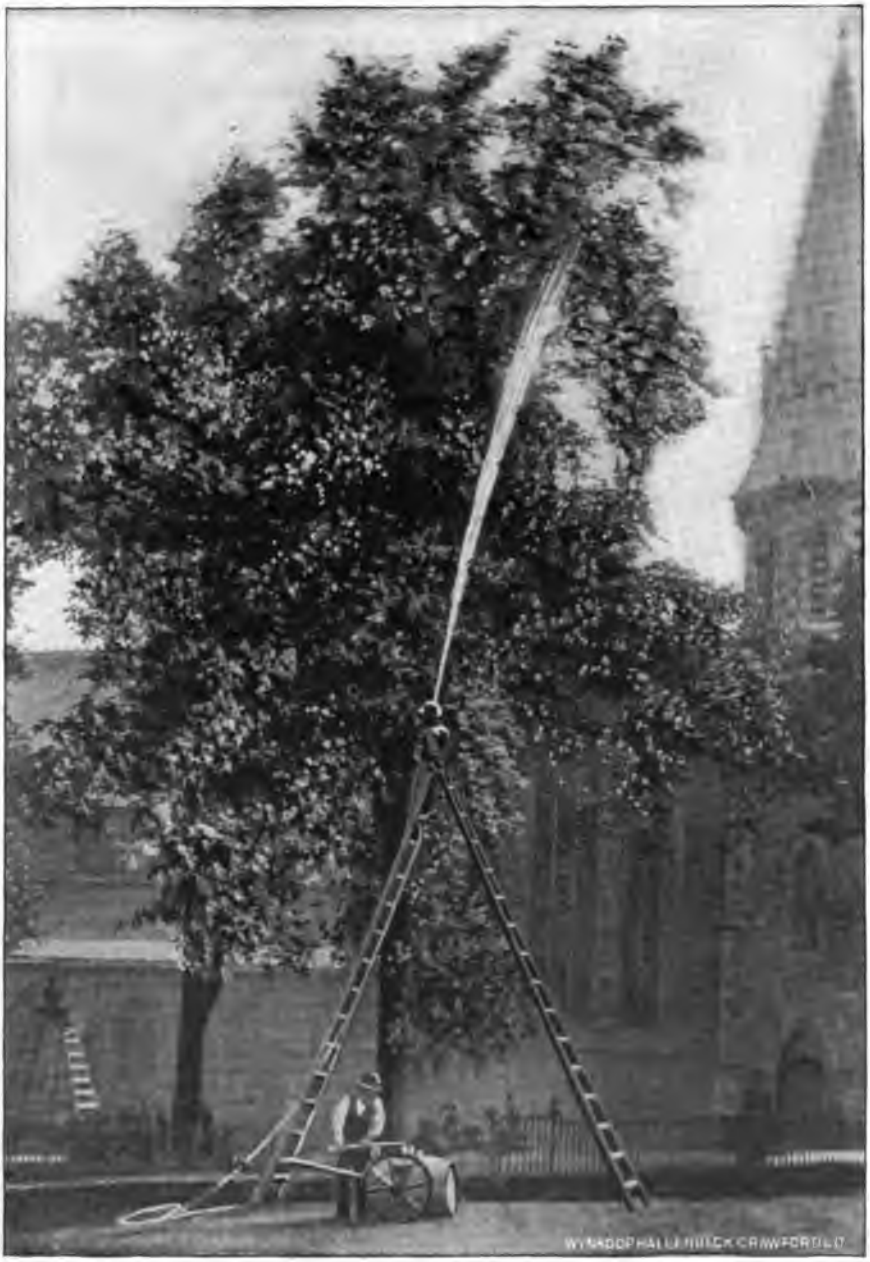
Work of elm leaf beetle on Jacob street, Troy

Photo 15 June 1898



Power spraying outfit in operation

Photo 15 June 1898



Hand spraying outfit in operation **Photo 15 June 1898**

1

2

Elm leaf beetle work.

2

1

Elm bark louse

INDEX

University of the State of New York

New York State Museum

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Reports 22-41, 48, 49, 50 and 52 (Museum bulletin 25) are out of print; 42-47 are inaccessible. Report 51 may be had for 40c; 53 for 20c; 54 for 50c. Beginning with 1901 these reports will be issued as bulletins.

Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have been published in volumes 1 and 3 of the 48th museum report and in volume 1 of the 49th, 51st and 52d reports. The botanical part of the 51st is available also in separate form. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged, and combined with others more recently prepared and constitute Museum memoir 4.

Entomologist's annual reports on the injurious and other insects of the State of New York 1882–date.

Bound also with museum reports of which they form a part. Beginning with 1898 these reports have been issued as bulletins. Reports 3-4 are out of print, other reports with prices are:

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2	.30	9	.25	14 (Mus. bul. 23)	.20
5	.25	10	.35	15 (" 31)	.15
6	.15	11	.25	16 (" 36)	.25
7	.20	12	.25	17 (" 53)	.30

Reports 2, 8-12 may also be obtained bound separately in cloth at 25c in addition to the price given above.

Museum bulletins 1887–date. O. *To advance subscribers, $2 a year or 50c a year for those of any one division: (1) geology, including economic geology, general zoology, archeology and mineralogy, (2) paleontology, (3) botany, (4) entomology.*

Bulletins are also found with the annual reports of the museum as follows:

Bulletins	*Report*	*Bulletins*	*Report*	*Bulletins*	*Report*
12–15	48, v. 1	20–25	52, v. 1	35–36	54, v. 2
16–17	50 "	26–31	53 "	37–44	" v. 3
18–19	51 "	32–34	54 "	45–48	" v. 4

The letter and figure in parentheses after the bulletin number indicate the division and series number. G=geology, EG=economic geology, Z=general zoology, A=archeology, M=mineralogy, P=paleontology, B=botany, E=entomology, Misc=miscellaneous.

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2 (B1) Peck, C: H. Contributions to the Botany of the State of New York. 66p. 2pl. May 1887. [*35c*]

3 (EG1) Smock, J: C. Building Stone in the State of New York. 152p. Mar. 1888. *Out of print.*

4 (M1) Nason, F. L. Some New York Minerals and their Localities. 20p. 1pl. Aug. 1888. *5c.*

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6 (E2) ——— Cut-worms. 36p. il. Nov. 1888. *10c.*

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7 (EG2) Smock, J: C. First Report on the Iron Mines and Iron Ore Districts in New York. 6+70p. map. June 1889. *Out of print.*

8 (B2) Peck, C: H. Boleti of the United States. 96p. Sep. 1889. [*50c*]

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New York State Museum

FREDERICK J. H. MERRILL Director

Bulletin 58

MINERALOGY 2

GUIDE TO THE

MINERALOGIC COLLECTIONS

OF THE

NEW YORK STATE MUSEUM

BY

HERBERT P. WHITLOCK C.E.

ALBANY

UNIVERSITY OF THE STATE OF NEW YORK

1902

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Bulletin 58

MINERALOGY 2

GUIDE TO THE

MINERALOGIC COLLECTIONS

OF THE

NEW YORK STATE MUSEUM

PREFACE

The kindly reception given to the *Guide to the Study of the Geological Collections of the New York State Museum*, published in 1898, and the evidences of its utility as a teachers' aid in the schools of the state, have made it seem desirable to continue this method of treatment in regard to the other branches illustrated in the New York State Museum.

Mr Whitlock, assistant in mineralogy, has accordingly, prepared for publication the following bulletin and it is offered to the citizens of the State of New York in the hope that it will meet a material want and aid many teachers in their instructional work in mineralogy by supplementing the textbooks now available.

FREDERICK J. H. MERRILL
Albany N. Y. July 14, 1902 *Director*

PART I

GENERAL PROPERTIES OF MINERALS

INTRODUCTORY DEFINITIONS

The science of mineralogy embraces a knowledge of all natural inorganic substances of definite chemical composition which go to make up the crust of the earth, and, so far as our knowledge extends, of other solid bodies in the universe.

Minerals, in the sense adopted in the following pages and generally in science, constitute only a part of the mineral kingdom. A mineral must be a homogeneous substance, that is, it must be of the same nature throughout. Many rocks which seem to the unaided eye to be composed of a single substance are shown by more careful examination under the microscope to be made up of more than one substance. A mineral must also have a definite chemical composition as expressed by a chemical formula. Thus, obsidian, or volcanic glass, though frequently quite homogeneous, is not classed as a mineral owing to its lack of definite composition.

Again, it is customary to exclude from the list of mineral species all substances which have not been formed by the processes of nature and such mineral substances as have been directly produced by organic life. Under this head are excluded laboratory and furnace products such as the carbonate of lime produced by passing carbon dioxid through limewater, which is not a mineral species though it has the same composition as the mineral calcite or natural carbonate of lime. Phosphate rock is not classed as a mineral owing to its organic origin though it has essentially the same composition as the mineral apatite which is the natural phosphate of lime.

The rocks which compose the earth's crust are either single minerals, such as marble, a massive form of calcite, or aggregates of two or more minerals. An example of the latter case is granite, composed of three or more separate and distinct minerals which may readily be recognized as different: a glassy mineral showing rough surfaces along the fracture, which is

called quartz; a white, pink or salmon colored mineral which shows on the fracture a series of smooth surfaces and which is called a feldspar; and a black fibrous mineral which is known as hornblende.

Crystallization

When a substance in the condition of a liquid or a gas becomes solid it is often seen that this solid has a regular outline, smooth, bright sides or faces and sharp angles. This results from the fact that the particles or molecules of the substance, which while it was liquid or gaseous rolled about on one another, have been in some way arranged, grouped and built up. To illustrate this, suppose a quantity of small shot to be poured into a glass, the shot will represent the molecules of a substance in

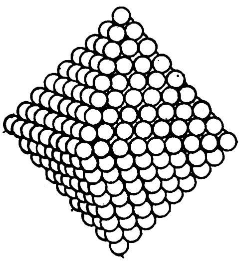

Fig. 1

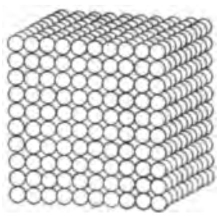

Fig. 2

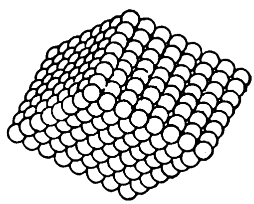

Fig. 3

the liquid state, as for example a solution of alum. If, now, we suppose these same shot to be coated with varnish or glue so that they will adhere to each other and imagine them grouped as shown in fig. 1 they will represent the arrangement of the molecules of the alum after it has become solid or crystallized. This arranging, grouping and piling up of the molecules is called crystallization and the solid formed in this way is called a crystal. Fig. 2 and 3 show the shot arranged to reproduce two common forms of crystals.

There are many common examples of crystallization. The snowflakes, which are formed by the cooling of watery vapor in the air, are composed of small crystals which are quite apparent to the eye and are often of great beauty and regularity of form. The same may be said of the frost which forms on a window

pane. The formation of crystals may be reproduced in a very striking manner; take for example a strong solution of salt and set it aside in a shallow dish over night; after the water has evaporated the bottom of the dish will be found covered with small cubic crystals of salt. The forces of nature working much more slowly but in a similar way have produced the vast deposits of native salt or halite which sometimes yield very large crystals.

Crystal masses

When a number of crystals are formed in a limited space the individual crystals intersect and lap over one another producing what is known as crystal masses. If this intersecting is carried to such an extent as to entirely fill the bounded space, leaving no interstices between the crystals, the mineral is said to be massive. The term massive in its broader sense includes mineral masses which do not show definite crystal faces but which in most cases can be shown to be distinctly crystalline by means of cleavage and optical properties. Experiment and study of mineral deposits show that a liquid substance which is cooled slowly or a solution which is concentrated gradually tends to form large and perfect crystals while substances which are solidified rapidly produce small and ill defined crystals, often giving rise to massive forms. A substance which displays no evidences of crystallization is said to be amorphous as distinct from crystalline. Glass is a good example of an amorphous substance.

Laws of crystals

A complete study of all known forms of crystallized substances has shown that the formation of crystals is subject to the following laws:

1 Law of constancy of interfacial angles

2 Law of symmetry

3 Law of simple mathematical ratio

Law of constancy of interfacial angles

In all crystals of the same substance the angle between any two like faces is constant. Fig. 4 and 7 show two crystals of

the mineral zircon, both being composed of the faces marked *p* and *m*. An examination of fig. 5, 6, 8 and 9,

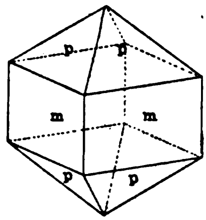

Fig. 4

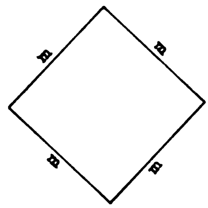

Fig. 5

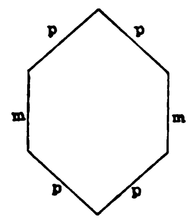

Fig. 6

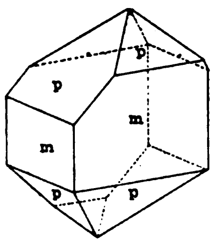

Fig. 7

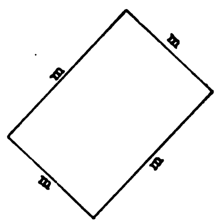

Fig. 8

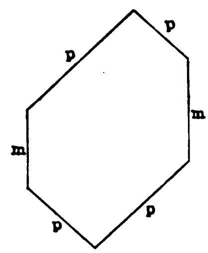

Fig. 9

which show sections through fig. 4 and 7, will demonstrate that the angles between *m* and *m* in fig. 5 and 8 are equal as are also the angles between *p* and *p* and between *p* and *m* in fig. 6 and 9. Compare the cardboard model 6[1], which shows the same crystal as fig. 4. Fig. 10 shows a distorted octahedron of magnetite, the shaded form within the outline representing the normal octahedron equally developed in all directions; the faces of the outer and inner forms are parallel each to each. The cardboard model 1 is an ideal octahedron.

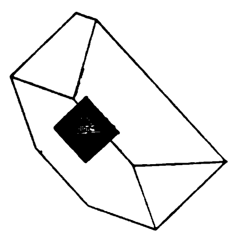
Fig. 10

Law of symmetry

By symmetry is meant the degree of regularity with which the faces and angles of a crystal are grouped about points, lines and planes. Thus a crystal may be symmetric to a plane, symmetric to a line or axis, symmetric to a point or center.

[1] The cardboard models will be found in a pocket attached to the cover.

A crystal is symmetric to a plane when it may be so divided by that plane that every face, edge and angle on the one side is repeated on the opposite side. In fig. 11, which represents a crystal of pyroxene, the shaded space shows the intersection

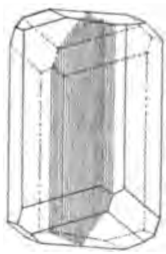

Fig. 11

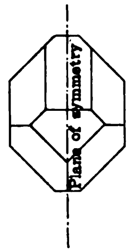

Fig. 12

of the crystal by a plane of symmetry, and it will be observed that the portion of the crystal lying to the right of the plane is related to the portion lying on the left in the same way that the reflected or mirrored image of the half crystal is related to the direct image. Fig. 12 shows fig. 11 as seen from above.

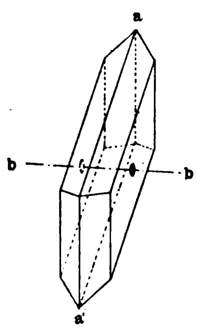

Fig. 13

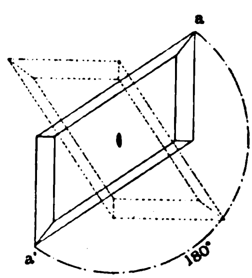

Fig. 14

A crystal is said to be symmetric to an axis of binary symmetry when it occupies the same position in space twice during one revolution about the axis, the coinciding positions being 180° apart. A consideration of fig. 13 and 14 will make this clearer; in fig. 13 *b* is an axis of binary symmetry and if the crystal is revolved as shown in fig. 14 the point *a* will have to traverse an arc of 180° and coincide with *a′* before the crystal

will occupy the same position in space. An axis of binary symmetry is indicated by this sign .

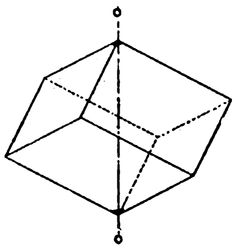

Fig. 15

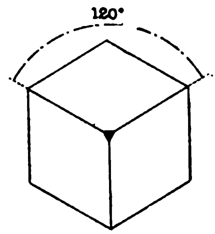

Fig. 16

Similarly a crystal is said to be symmetric to an axis of trigonal symmetry when it occupies the same position in space

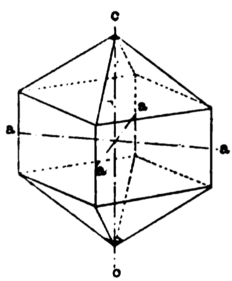

Fig. 17

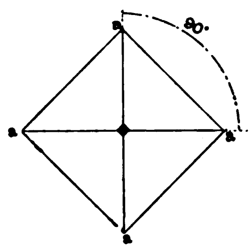

Fig. 18

three times during one revolution about the axis, the coinciding positions being 120° apart. Fig. 15 and 16 show a crystal of

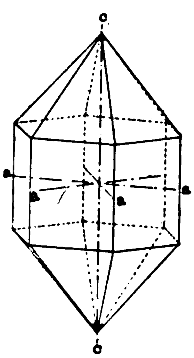

Fig. 19

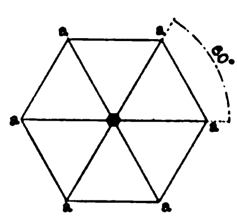

Fig. 20

calcite, *c–c* being an axis of trigonal symmetry, indicated by the sign ▲. Compare model 7.

A crystal is symmetric to an axis of tetragonal symmetry when it occupies the same position in space four times during one revolution about the axis, the coinciding positions being 90° apart. Fig. 17 and 18 show a crystal of zircon, *c–c* being an axis of tetragonal symmetry indicated by the sign ◆.

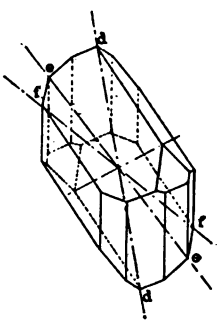

Fig. 21

Hexagonal symmetry is shown when a crystal occupies the same position in space six times during one complete revolution about the axis of symmetry, the coinciding positions being 60° apart. Fig. 19 and 20 show a crystal of quartz, *c–c* being an axis of hexagonal symmetry indicated by the sign ⬢.

A crystal is symmetric to a point or center when every imaginary straight line passing through that point intersects the crystal at its two extremities in similar faces, edges or solid angles. This is the least symmetric of all the conditions so far discussed and is illustrated by the crystal of chalcanthite or blue vitriol shown in fig. 21.

Crystallographic axes

The relations between the faces of a crystal are best studied by assuming certain directions within the crystal called axes. Such axes may, in the more symmetric groups, be axes of symmetry, and when the crystal is symmetric to one or more planes of symmetry, they bear a definite relation to those planes.[1] Three (in one system four) such axes are chosen, their relative inclination and lengths forming a basis for classifying all crystals into six systems.

If the symmetry of a crystal permits the grouping of faces around one axis to be identical with the grouping of faces around another, the two axes are said to be interchangeable. In fig. 17 and 18 the axes marked *a* are interchangeable but

[1] In the normal groups of the isometric, tetragonal, hexagonal and orthorhombic systems, the axes are found at the intersection of the planes of symmetry, and in the normal group of the monoclinic system two axes lie in the plane of symmetry and a third is perpendicular to it.

a and *c* are not interchangeable. The same statement holds good for fig. 19 and 20. Cardboard models 6 and 7 will help to make this clear. Fig. 16, 18 and 20 show that if one crystallographic axis is also an axis of trigonal, tetragonal or hexagonal symmetry the other crystallographic axes will be at right angles to it and interchangeable.

Crystal form

When every face of a crystal cuts the axes to which it is referred at the same relative distances from the center or inter-

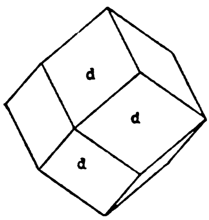

Fig. 22

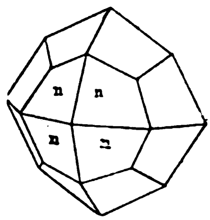

Fig. 23

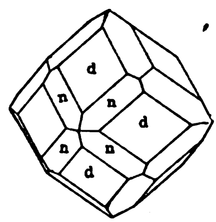

Fig. 24

section of the axes, the crystal is said to be composed of a single crystal form. Two such crystals are shown in fig. 22 and 23 from which it will be noticed that all the faces of each crystal form are similar. Compare models 1, 2, 3, 4 and 5, all of which are crystal forms. Crystals may be composed of a single crystal form or of combinations of two or more forms. Such a combination is shown in fig. 24 which is made up of the two forms shown in fig. 22 and 23.

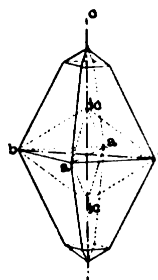

Fig. 25

Law of simple mathematical ratio

If the faces of a crystal are extended to intersect the axes it will be found that these points of intersection lie at the ratio distance *a*, *b*, and *c* characteristic of the substance, or at distances which are simple multiples or fractions of these ratio distances. Should a plane be parallel to one or two of the axes its intercepts, or in other words the relative distances from the center at which it cuts these axes, are infinity. Assuming the

axes *a-a*, *b-b* and *c-c* (fig. 25) of the ratio or unit lengths of sulfur, that is to say,

$$a\text{–}a: \ b\text{–}b: \ c\text{–}c: \ = \ 0.813: \ 1: \ 1.903$$

possible crystal faces of sulfur might have intercepts

$$\begin{array}{rcl} a: \ b: \ c: & = & .813: \ 1: \ 1.903 \\ 3a: \ b: \ c: & = & 3(.813): \ 1: \ 1.903 \\ a: \ b: \tfrac{1}{3}c: & = & .813: \ 1: \ \tfrac{1}{3}(1.903) \\ \infty: \ b: \ c: & = & \infty: \ 1: \ 1.903 \text{ etc.} \end{array}$$

The quantities by which the ratio distances of any substance must be multiplied to give the intercepts for any ordinary crystal form of that substance are infinity and such simple numbers as 1, 2, 3, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{3}{2}$, etc. Fig. 25 shows the crystal resulting from the combination of the crystal forms a:b:c: and a: b:$\frac{1}{3}$c of sulfur.[1]

Systems of crystallization

Crystals of all known forms, however varied and complicated, may be classified under the following six systems of crystallization, which will be taken up in detail.

1 Isometric
2 Tetragonal
3 Hexagonal
4 Orthorhombic
5 Monoclinic
6 Triclinic

[1] Instruments employed for the measurement of interfacial angles are known as goniometers and are represented by two types: 1) contact goniometers which measure on a graduated half circle the angle obtained by directly applying to the faces of the crystal two pivoted arms; 2) reflection goniometers which operate on the principle of reflection from the brilliant crystal faces of the image of a point of light. The crystal is attached to a rotating graduated circle on which the required angle is read. Of the two types the latter is by far the more accurate particularly for small crystals.

The polarizing microscope, which is extensively used in determining the optical properties of minerals and in the study of rocks, differs from the ordinary microscope in three essential features.

1 It is equipped with a revolving stage centered in the axis of the microscope and graduated on the circumference.

2 Below the stage is inserted a device which polarizes the light that passes from the reflector, that is to say only those rays of light that vibrate parallel to a certain plane are transmitted.

3 Above the stage is placed a similar polarizing device called the analyzer which transmits the light that vibrates in planes perpendicular to the plane of the lower polarizer.

These two polarizing devices, known as nicols prisms or "nicols," are constructed from cleavage rhombohedrons of transparent calcite and are so arranged that they are readily inserted or removed.

Isometric system

Crystals included in the isometric system can be referred to three interchangeable axes at right angles to each other.[1] The molecular structure of the mineral with respect to these axes is revealed not only by the outward form of the crystal but by the property, common to all isometric minerals, of transmitting polarized light equally in all directions. By virtue of this property a thin section of an isometric mineral cut in any direction will remain dark when viewed in a polarizing microscope between crossed nicols or when observed in a similar way in the tourmalin tongs. There are five groups, differing slightly in symmetry, included in the isometric system, three of which contain nearly all the isometric minerals known.

Any mineral of which definite crystals are found produces forms which show the symmetry of a distinct group, and *it is impossible to find in nature a crystal whose symmetry would place it in more than one group.*

Normal group

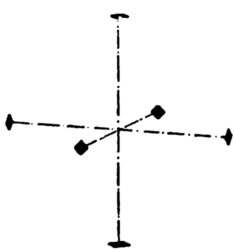

Fig. 26

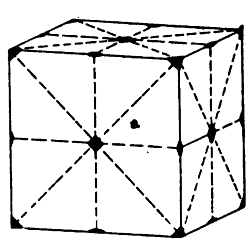

Fig. 27

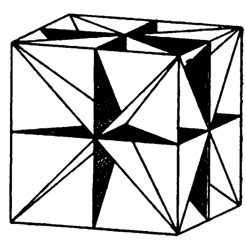

Fig. 28

The general symmetry of this group is shown in fig. 26 and 27. The crystallographic axes are axes of tetragonal symmetry and any form belonging to the group, as for example the cube shown in fig. 27, must be symmetric to the planes which inter-

[1] In the ideal representation of an isometric crystal these axes are equal. Such a condition, however, seldom occurs in nature, the crystal being distorted in various directions. In the following brief outline, as well as in the description of mineral species, the diagrams represent ideal crystals and the reader's attention is directed to the symmetry and distribution of the faces shown, which are invariable however much the actual crystal may be distorted.

sect, as shown in fig. 28. The shaded planes of fig. 28 intersect in axes of tetragonal symmetry, the white planes intersect in axes of trigonal symmetry.

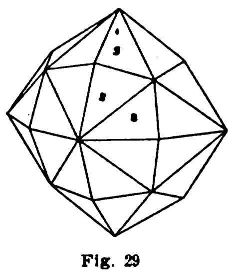

Fig. 29

Hexoctahedron. The hexoctahedron (fig. 29) is composed of 48 faces, each cutting the three axes at relatively different distances. The faces, which are scalene triangles, are grouped around the trigonal axes in groups of six.

Cube. The cube (fig. 27, model 2) is composed of six square faces each of which is parallel to two axes. This crystal form is represented by a number of minerals, the most common being galena, fluorite, halite, etc.

Dodecahedron. The dodecahedron (fig. 30, model 3) is composed of 12 rhombic faces, each of which cuts two axes at the same relative distance and is parallel to the third. This crystal form is quite common in garnet, and is found to a less degree in magnetite and other minerals.

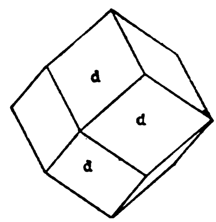

Fig. 30

Tetrahexahedron. The tetrahexahedron (fig. 31) is composed of 24 faces each of which is parallel to one axis and cuts the other two at relatively unequal distances. The faces, which are isosceles triangles, are grouped in fours about the axes of tetragonal symmetry and the long edges are parallel to the edges of a cube or hexahedron. This crystal form, in combination, is well illustrated by copper, fluorite and other minerals.

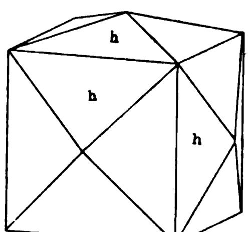

Fig. 31

Octahedron. The octahedron (fig. 32, model 1) is composed of eight equilateral triangular faces which cut the three axes equally. Good examples of this form may be found in crystals of magnetite and spinel.

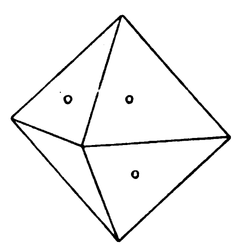

Fig. 32

Trisoctahedron. The trisoctahedron (fig. 33) is composed of 24 faces, each of which cuts two axes at equal distances and the third at a distance which is relatively greater. The faces are isosceles triangles and are disposed in groups of eight about the axes of tetragonal symmetry and in groups of three about the axes of trigonal symmetry. The trisoctahedron is occasionally found in combination with other forms as in galena.

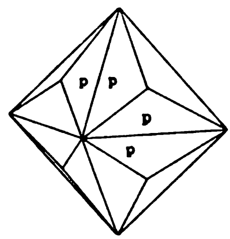

Fig. 33

Trapezohedron. The trapezohedron (fig. 34) is composed of 24 faces each of which cuts two axes at equal distances and the third at a distance which is relatively less. Garnet, leucite, analcite and other minerals crystallize in trapezohedrons.

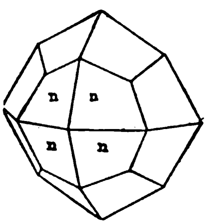

Fig. 34

Of the above named crystal forms the cube, dodecahedron and octahedron alone present an unvarying constancy of form, the cube and octahedron being identical with the familiar geometric forms. In the hexoctahedron, tetrahexahedron, trisoctahedron and trapezohedron the variations in the relative values of the axial intercepts give rise to a number of variations under

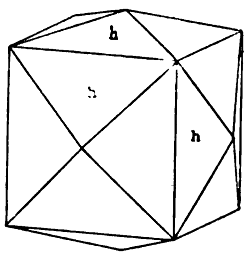

Fig. 35

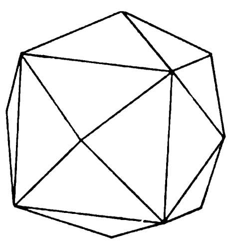
Fig. 36

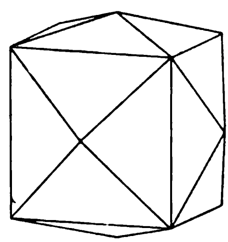
Fig. 37

each form, each subject to the law of simple mathematical ratio. The series of tetrahexahedrons shown in fig. 35–37 serves to illustrate this point. Fig. 35 and 37 are forms occurring in copper and fig. 36 is frequently observed on crystals of fluorite.

Some of the combinations of forms in this group are given in fig. 38–43, the lettering of the faces being the same as that used for the corresponding simple forms.

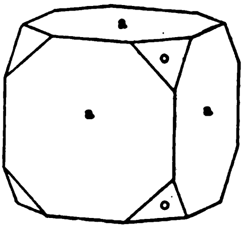

Fig. 38

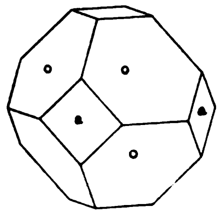

Fig. 39

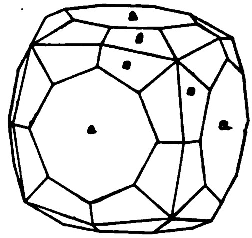
Fig. 40

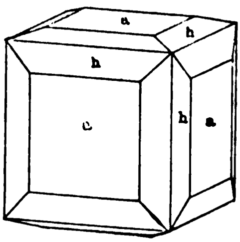

Fig. 41

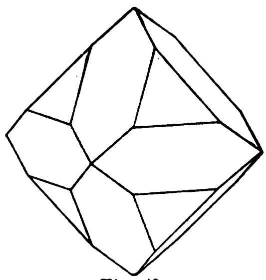
Fig. 42

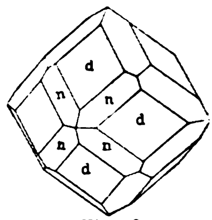

Fig. 43

Pyritohedral group

The general symmetry of the pyritohedral group is shown in fig. 44. The crystallographic axes are axes of binary symmetry

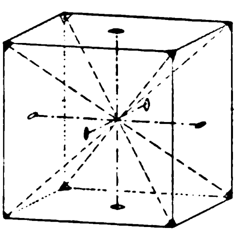
Fig. 44

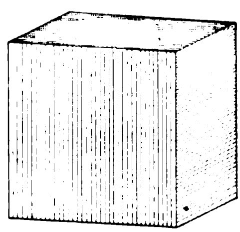
Fig. 45

and forms of this group are symmetric only to the shaded planes of fig. 28. The cube, octahedron, dodecahedron, trisoctahedron and trapezohedron, which occur in this as well as in the preceding group, are here distinguished by striations, natural etching and modifying faces which clearly show their binary symmetry; as for example the cube of pyrite shown in fig. 45, which occurs striated in the directions of the alternate parallel edges of each square face.

Pyritohedron. The pyritohedron (fig. 46, 47, model 4) is named from the species pyrite, of which it is a characteristic form.

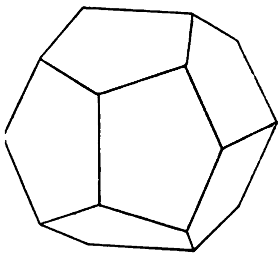

Fig. 46

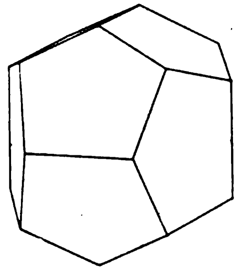

Fig. 47

It is composed of 12 pentagonal faces, each of which is parallel to one axis and meets the other two at unequal distances. As will be seen from fig. 46 and 47 the pyritohedron exists in complementary forms, fig. 46 being known as the *plus* and fig. 47 as the *minus* form. The 24 faces of the plus and minus pyritohedrons have the same position in space as the 24 faces of the corresponding tetrahexahedron of the normal group.

Diploid. The diploid (fig. 48, 49) is composed of 24 quadrilat-

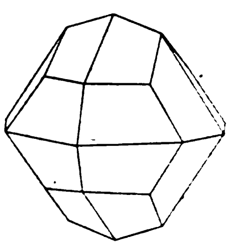

Fig. 48

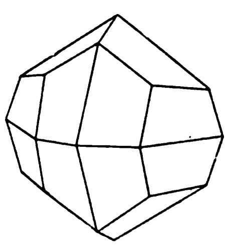

Fig. 49

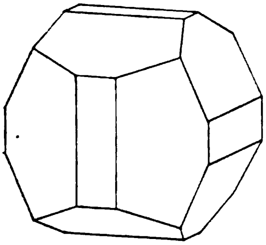

Fig. 50

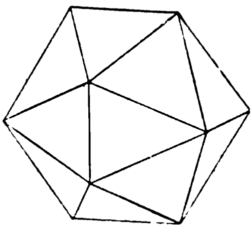

Fig. 51

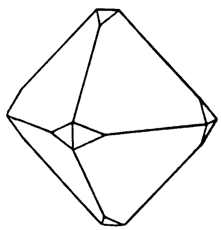

Fig. 52

eral faces each of which meets the axes at unequal distances. The complementary plus (fig. 48) and minus (fig. 49) forms bear the same relation to the hexoctahedron of the normal group

as the plus and minus pyritohedrons do to the tetrahexahedron. Fig. 50–52 show combinations of forms in this group and represent crystals of pyrite and cobaltite.

Tetrahedral group

The general symmetry of this group is shown in fig. 53. The crystallographic axes are axes of binary symmetry and the crystals of this type are symmetric to the six white planes of fig. 28. The cube, dodecahedron and tetrahexahedron occur in this group but are readily distinguished from the same forms of the normal type by the degree of symmetry shown in their combinations with other forms. The axes of trigonal symmetry indicated in fig. 53 constitute a characteristic feature of the group.

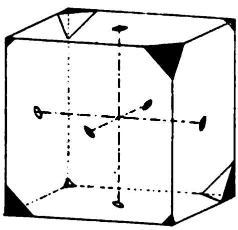

Fig. 53

Tetrahedron. The tetrahedron (fig. 54, 55, model 5) is composed of four equilateral triangular faces each of which meets the axes at equal distances. Two tetrahedrons are possible and are known as plus (fig. 54) and minus (fig. 55), the eight faces composing them corresponding to the eight like faces of the octahedron.

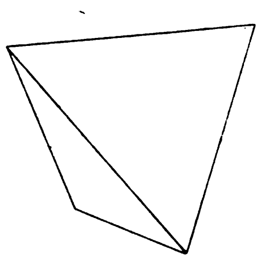

Fig. 54

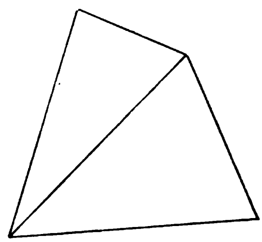

Fig. 55

Trigonal tristetrahedron. The trigonal tristetrahedron (fig. 56, 57) is composed of 12 triangular faces each of which meets two axes at equal distances and the third at a distance which is relatively less than the intercept on the other two. A plus trigonal tristetrahedron is shown in fig. 56 and the corresponding minus form in fig. 57; these bear a relation to the trapezo-

hedron of the normal group similar to that of the tetrahedron to the octahedron.

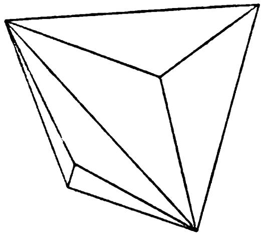
Fig. 56

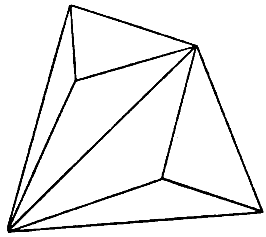
Fig. 57

Two other forms, the tetragonal tristetrahedron (fig. 58) and the hexakistetrahedron (fig. 59) are occasionally found in combination. Some combinations in this group are shown in fig. 60–65.

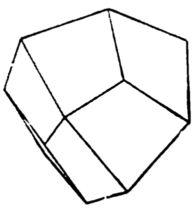
Fig. 58

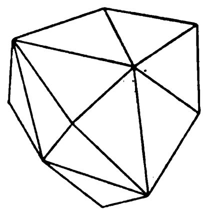
Fig. 59

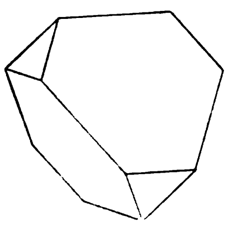
Fig. 60

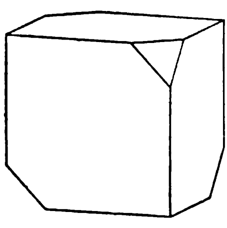
Fig. 61

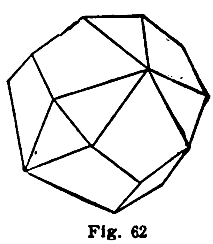
Fig. 62

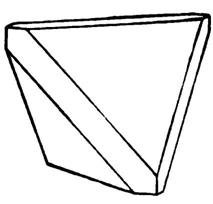
Fig. 63

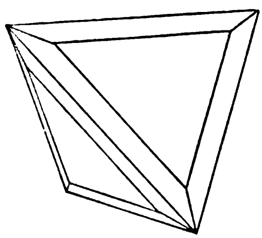
Fig. 64

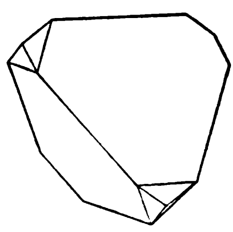
Fig. 65

Tetragonal system

Crystals in the tetragonal system can be referred to three axes, all at right angles to one another, two of which are equal and interchangeable (denoted in fig. 66 by *a*) and the third (*c*) is at right angles to the plane of the other two and is of a different length (greater or less) from the *a* axes.

The relative lengths of the *a* and the *c* axes vary in each tetragonal species, though there are several instances where this ratio differs to such a small degree in several species as to warrant placing them together in what is known as an isomorphous group.[1]

Normal group

The general symmetry of this group is shown in fig. 66. The vertical axis *c* is an axis of tetragonal symmetry and the horizontal axes *a a* are axes of binary symmetry. There are moreover two axes of binary symmetry which bisect the angles between the axes *a a*. Any form in the group is symmetric to the planes shown in fig. 67. Compare model 6.

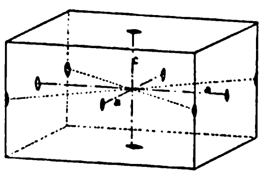

Fig. 66

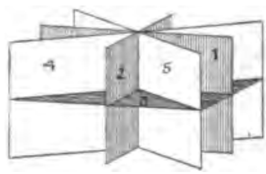

Fig. 67

Pyramids. A form composed of planes which intersect the horizontal axes *a a* at equal distances and which also intersect the vertical axis *c* is known as a pyramid of the first order and is composed of eight isosceles triangular faces. When the intercept on *c* as compared with that on *a* gives the axial ratio for any species the form is said to be the unit pyramid for that species. Fig. 68 shows the unit pyramid of zircon, the value of *c* for zircon being .64. Fig. 69 shows the unit pyramid of octahedrite where $c=1.777$.

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[1] See p. 45.

For each tetragonal species there may be several pyramids of the first order intersecting the vertical axis at multiples or

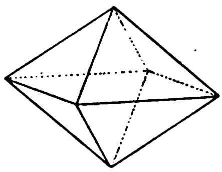


Fig. 68

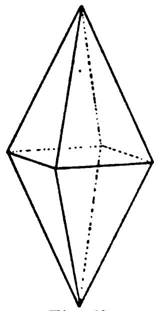


Fig. 69

fractions of the unit length *c* and producing steeper or flatter forms than the unit pyramid.

The pyramid of the second order is composed of eight isosceles triangles each of which is parallel to one horizontal axis *a* and intersects the second horizontal axis *a* and the vertical axis *c*. The second order pyramid of zircon is shown in fig. 70.

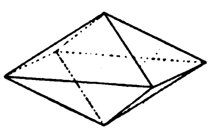


Fig. 70

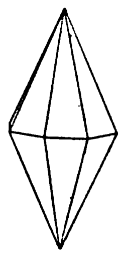


Fig. 71

The ditetragonal pyramid (fig. 71) is composed of 16 isosceles triangular faces intersecting the horizontal axes at unequal distances and also intersecting the vertical axis.

Prisms. For each type of pyramid in the normal group there is a corresponding prism having the same relative intercepts on the horizontal axes as the pyramids of the same name, and having every face parallel to the vertical axis. These prisms are denoted as follows:

Prism of the first order, having four faces, represented in fig. 72 by the faces marked *m*.

Prism of the second order, having four faces, represented in fig. 73 by the faces marked *a*.

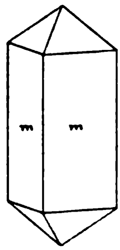


Fig. 72

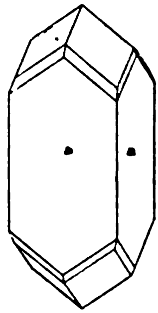


Fig. 73

Ditetragonal prism, having eight faces.

The basal plane or base consists of a pair of planes parallel to the horizontal or basal axes.

The symmetry of this group can be best observed by considering what is called the termination of the crystal, that is, the

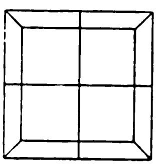


Fig. 74

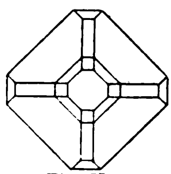


Fig. 75

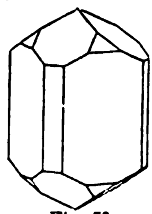


Fig. 76

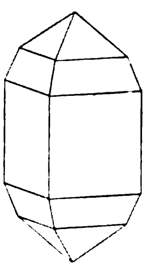


Fig. 77

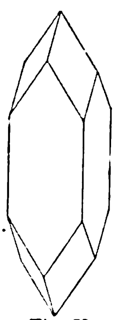


Fig. 78

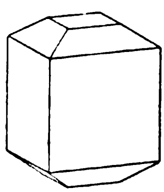


Fig. 79

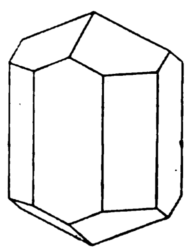


Fig. 80

way in which the planes are grouped about the extremity of the vertical axis; two such terminations are shown in plan in fig. 74 and 75. Some of the combinations in the normal group are shown in fig. 72–80.

Pyramidal group

The general symmetry of this group is shown in fig. 81; as in the normal group the vertical axis is an axis of tetragonal symmetry; a single plane of symmetry passes through the horizontal axes, which are not axes of binary symmetry as is the case in the normal group.

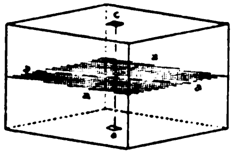


Fig. 81

The forms which have been described under the normal group occur also in the pyramidal group with the exception of the ditetragonal prism and pyramid.

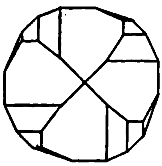


Fig. 82

The relation between the symmetry of this group and that of the preceding one may be best studied by referring to fig. 82 which shows the termination of a pyramidal crystal. The absence of vertical planes of symmetry, characteristic of this group should be noted.

Two new forms occur, namely: prism of the third order, represented in fig. 84; pyramid of the third order, represented in fig. 83 by the faces marked *x*.

The relations of the pyramid and prism of the third order

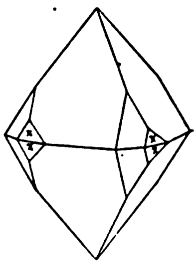


Fig. 83

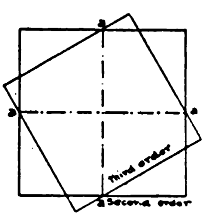


Fig. 84

to the corresponding forms of the first and second order are shown in fig. 84. Fig. 83 represents some combinations in this group.

Sphenoidal group

The general symmetry of this group, which is shown in fig. 85, is somewhat analogous to that of the tetrahedral group of the isometric system. The crystallographic axes are axes of

binary symmetry and there are moreover, two vertical planes of symmetry (fig. 67, no. 4, 5).

This symmetry admits of two new forms.

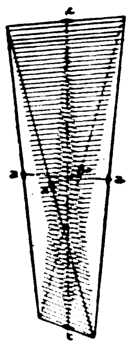


Fig. 85

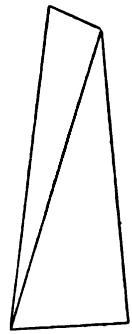


Fig. 86

1 The tetragonal sphenoid (fig. 85, 86) is composed of four isosceles triangles which meet the horizontal axes at equal distances; they also intersect the vertical axis. Two sphenoids are possible which include all the faces of the pyramid of the first order of the normal group. The form is analogous to the tetrahedron of the isometric system.

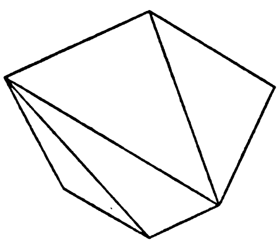


Fig. 87

2 The tetragonal scalenohedron (fig. 87) is composed of eight scalene triangles, which intersect the horizontal axes unequally. As with the sphenoid there are two complementary scalenohedrons possible for every different ratio of the intercepts on the horizontal axes. Up to the present time the scalenohedron has been found only in combination with other crystal forms of this group.

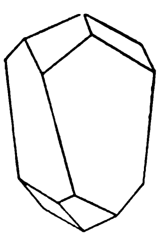


Fig. 88

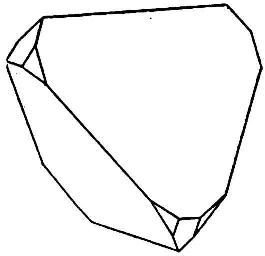


Fig. 89

Some of the combinations in this group are shown in fig. 88 and 89, which illustrate crystals of chalcopyrite.

Hexagonal system

There are in general many points of resemblance between hexagonal crystals and those which are included in the tetragonal system. This analogy is accentuated by the fact that the molecular structure of the minerals in both systems as exhibited in their optical properties show striking similarity. Hexagonal as well as tetragonal crystals are said to be optically uniaxial; that is, in every crystal of these two systems a section cut normal to the vertical axis will remain dark when viewed between crossed nicols in the polarizing microscope; any other section will show an interference color which changes to darkness or "extinction" at regular intervals as the stage of the microscope is rotated.

Hexagonal crystals are referred to four crystallographic axes, one of which is vertical and perpendicular to the plane of the other three; this vertical axis, as in the tetragonal system, is indicated by *c*. The three horizontal axes are interchangeable and at 60° from each other; they are indicated by *a*.

A Hexagonal division

Normal group

The general symmetry of this group is shown in fig. 90 and 91. The vertical axis is an axis of hexagonal symmetry and each

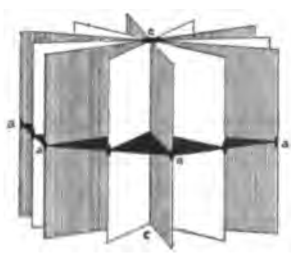


Fig. 90

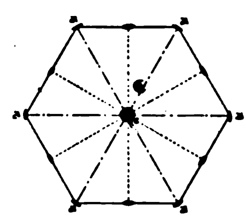


Fig. 91

basal axis is an axis of binary symmetry; there are also three axes of binary symmetry bisecting the angles between the crystallographic axes. Crystals in this group are symmetric to a plane of symmetry through the basal axes and to six planes of symmetry passing through the vertical axis and each of the axes of binary symmetry. The nomenclature of the forms is analogous with that used in the normal group of the tetragonal system, the forms being briefly stated as follows:

PYRAMIDS

	FIG.
Pyramid of the first order	92
Pyramid of the second order	93
Dihexagonal pyramid	94

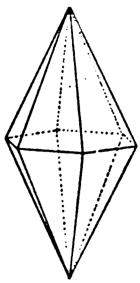


Fig. 92

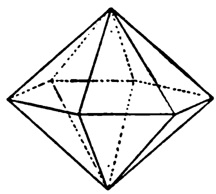


Fig. 93

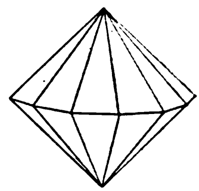


Fig. 94

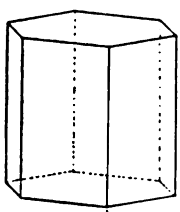


Fig. 95

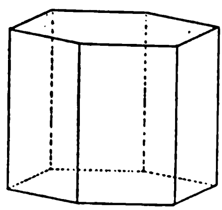


Fig. 96

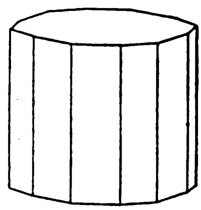


Fig. 97

PRISMS

	FIG.
Prism of the first order	95
Prism of the second order	96
Dihexagonal prism	97

The basal pinacoid is shown terminating the prisms in fig. 95-97. The relation of these forms to one another is shown in fig.

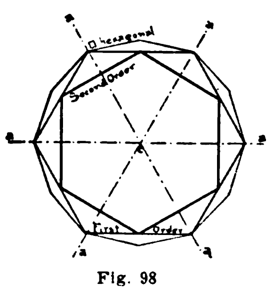


Fig. 98

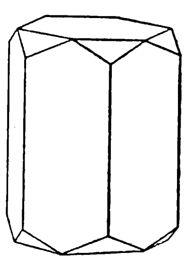


Fig. 99

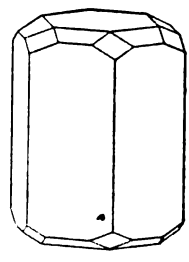


Fig. 100

98. Two combinations in the normal group are shown in fig. 99 and 100, which represent crystals of beryl.

Pyramidal group

The symmetry of this group resembles that of the pyramidal group of the tetragonal system in that crystals of this type are symmetric to the horizontal plane of symmetry shown in fig. 90. The vertical axis (*c*) is an axis of hexagonal symmetry. Fig. 101 gives an idea of the general arrangement of faces about

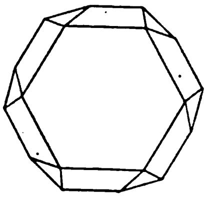


Fig. 101

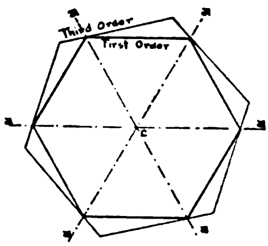


Fig. 102

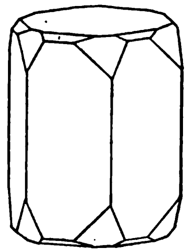


Fig. 103

this axis. The third order pyramid and prism, indicated in plan in fig. 102, are of frequent occurrence in this group, as well as the pyramids and prisms of the first and second order described above.

The crystal of vanadinite shown in fig. 103 illustrates a combination of pyramidal forms. Apatite and pyromorphite are common minerals in this group.

B Rhombohedral division

The groups which come under this division differ from the hexagonal forms hitherto discussed in the essential feature of a vertical axis of trigonal symmetry which gives to the termination of rhombohedral crystals a trigonal as distinct from a hexagonal aspect. Compare fig. 104, which shows a termination of a rhombohedral crystal, with the hexagonal terminations shown in fig. 91 and 101. Compare also model 8 with model 7.

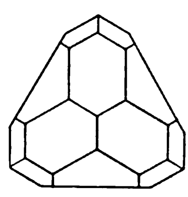


Fig. 104

Rhombohedral group

Forms in this group are characterized by a vertical axis of trigonal symmetry and three horizontal axes of binary symmetry, these axes being identical with the crystallographic axes. They are also symmetric to three planes which intersect in the vertical axis as shown in fig. 105.

Rhombohedron. The rhombohedron (fig. 106, 107, model 8) is composed of six rhombic faces, each of which intersects two basal axes at equal distances, is parallel to the third and cuts the vertical axis (c). The two rhombohedrons possible for every relative value of the vertical intercept are complementary plus (fig. 106) and minus (fig. 107); the 12 faces of the plus and minus rhombohedrons include all the faces of a hexagonal pyramid of the first order having the same relative intercepts. Some rhombohedrons of calcite of varying vertical intercepts are shown in fig. 107-9.

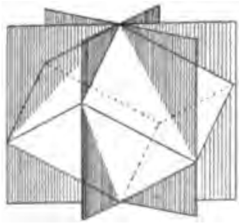


Fig. 105

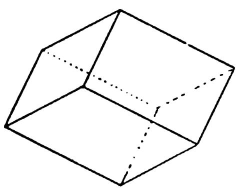


Fig. 106

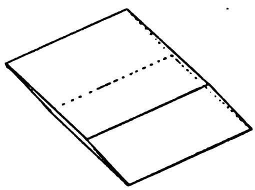


Fig. 107

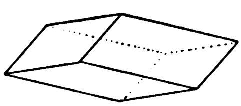


Fig. 108

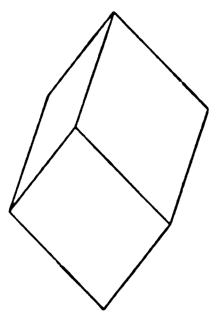


Fig. 109

Scalenohedron. The scalenohedron (fig. 110) is composed of 12 scalene triangular faces each of which cuts all four axes. As with the rhombohedron two forms are possible for every value of the vertical intercept. These are related to the dihexagonal pyramid in the same way that the rhombohedron is related to the pyramid of the first order.

The remaining forms of the rhombohedral group are geometrically the same as the corresponding forms of the normal group and are: prism of the first order; prism of the second order; pyramid of the second order; basal plane.

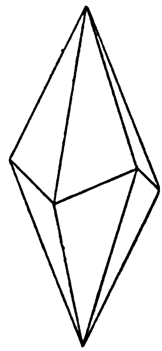


Fig. 110

Some of the combinations in this group are shown in fig. 111-13.

Rhombohedral-hemimorphic group

Comparing this group with the preceding one, the main points of difference to be noted are the lack of symmetry to a point, which is characteristic of hemimorphic crystals, the two extremities of the vertical axis showing dissimilar modifications, and the fact which results from the above, namely, that the horizontal

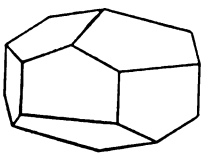


Fig. 111

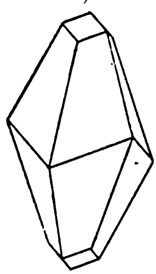


Fig. 112

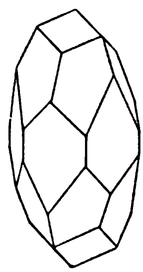


Fig. 113

axes are no longer axes of binary symmetry. A crystal of tourmalin, which is an important species of this type, is shown in fig. 114 and serves to illustrate the main features of the group.

Trirhombohedral group

Trirhombohedral crystals are characterized by the absence of planes of symmetry; they are, however, symmetric to a point.

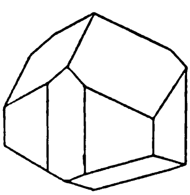


Fig. 114

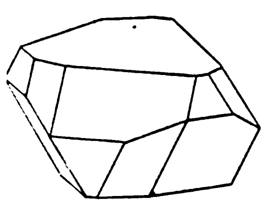


Fig. 115

The vertical axis is an axis of trigonal symmetry. The minerals ilmenite, dolomite, phenacite, dioptase and willemite occur in forms of this group. Fig. 115 shows a crystal of ilmenite.

Trapezohedral group

The forms in this group possess the lowest grade of symmetry in the hexagonal system, having no plane of symmetry and no center of symmetry; the vertical axis is, however, an axis of trigonal symmetry and the three horizontal axes (*a*) are axes of binary symmetry.

Trapezohedron. The trigonal trapezohedron (fig. 116, 117) is a characteristic form of this group and consists of six trapezohedral faces each of which cuts all the axes.

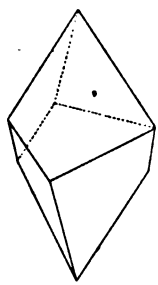


Fig. 116

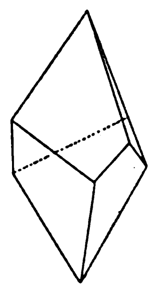


Fig. 117

Four trapezohedrons are possible; two plus, called respectively right-handed (fig. 116) and left-handed (fig. 117), and two minus forms which are also right-handed and left-handed.

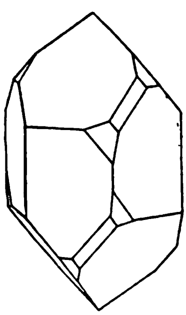


Fig. 119

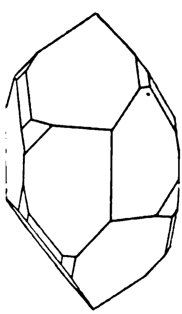


Fig. 120

The 24 faces of these four forms constitute the planes of a dihexagonal pyramid.

The two crystals of quartz shown in fig. 119, 120 show the trigonal trapezohedron in combination with other forms of the group; they are termed respectively right-handed and left-handed forms.

Trigonal pyramid. The trigonal pyramid (fig. 118) consists of six triangular faces, each of which cuts two basal axes (a) at equal distances and the third at a distance which is relatively half as great, each face also interests the vertical axis.

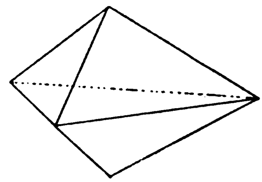


Fig. 118

Orthorhombic system

Crystal forms included in the orthorhombic system are referred to three unequal uninterchangeable axes at right angles to one another. These axes are shown in fig. 121; the shorter horizontal one, called the brachyaxis, is designated by a, the longer horizontal axis, called the macroaxis, by b and the vertical axis by c. The relative position of the macro and brachy

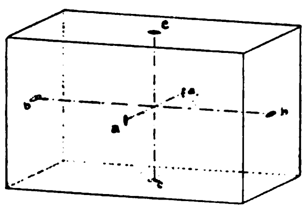


Fig. 121

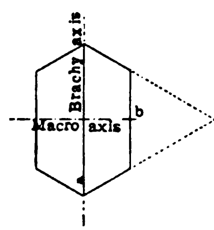


Fig. 122

axes in a crystal of any orthorhombic species is determined by the intercepts of a face occurring in that species, called a unit plane. The unit plane is selected from among those which cut both a and b axes and is preferably a plane which intersects all three axes. The intercepts of the a and c axes in terms of b constitute the axial ratio, which is a constant for each orthorhombic species. Difficulty is sometimes experienced in properly orienting an orthorhombic crystal owing to the fact that the crystal is often flattened in the direction of the macroaxis; thus in fig. 122, which shows a crystal of cerussite in plan, the brachyaxis *appears* to be longer than the macro because the crystal is elongated in the direction of a.

Normal group

Forms of the normal group are symmetric to three planes of symmetry intersecting in the crystallographic axes, which are axes of binary symmetry (fig. 123).

Pinacoids. Planes which are parallel to two orthorhombic axes are known as pinacoids; they consist of two parallel planes and take their names from the axes to which they are parallel, thus:

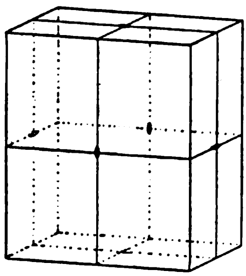


Fig. 123

The basal pinacoid is parallel to both basal axes *a* and *b*.

The macropinacoid is parallel to the macro and the vertical axis.

The brachypinacoid is parallel to the brachy and the vertical axis.

Fig. 123 shows the intersection of these three pinacoids, the resulting solid being analogous to the cube of the isometric system and the second order prism and base of the tetragonal system.

Prisms. Prisms cut both horizontal axes, and are parallel to the vertical axis; they are composed of four faces, opposite pairs being parallel. The unit prism for any species intersects the basal axes at relative distances which give the axial ratio for that species. In fig. 124, which shows a basal section of the mineral topaz, such a unit prism is indicated, the axial ratio for topaz being a:b=.529:1.

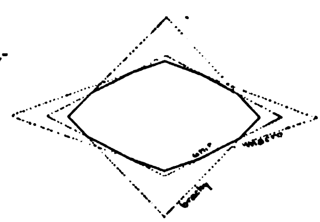


Fig. 124

Prisms occur intersecting the basal axes at distances proportionately more or less than the axial ratio subject to the law of

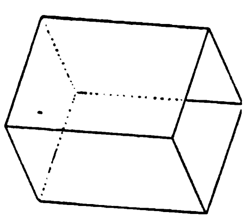


Fig. 125

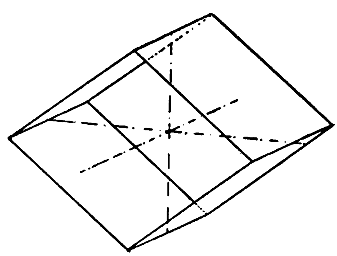


Fig. 126

rational indexes. These are called respectively macro or brachy prisms according as they are more nearly parallel to the macro or brachy axis than the unit prism. A macro and a brachy prism are shown in fig. 124.

Domes. Domes may be considered horizontal prisms; they are parallel to one horizontal axis and cut the other horizontal axis and the vertical axis. Like the pinacoids they take their names from the axes to which they are parallel thus:

The macrodome (fig. 125) is parallel to the macroaxis and cuts the brachy and the vertical axes.

The brachydome (fig. 126) is parallel to the brachyaxis and cuts the macro and the vertical axes.

Macrodomes and brachydomes are often repeated in series, the relative value of the vertical intercepts being subject to the law of rational indexes.

Pyramids. The single type of pyramid found in this system is shown in fig. 127 and is composed of eight faces each cutting all three axes. The unit pyramid for any species intersects the axes at distances corresponding to the axial ratio for the species.

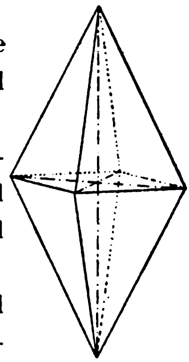


Fig. 127

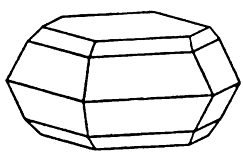


Fig. 128

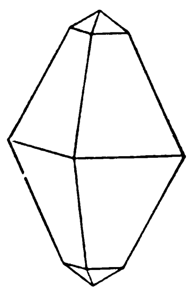


Fig. 129

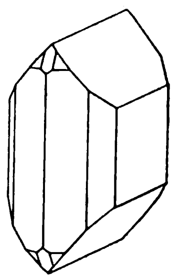


Fig. 130

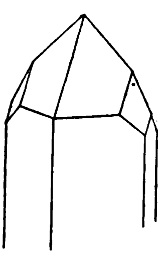


Fig. 131

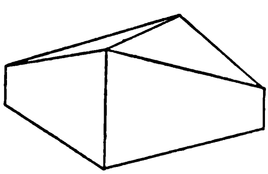


Fig. 132

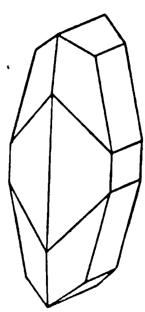


Fig. 133

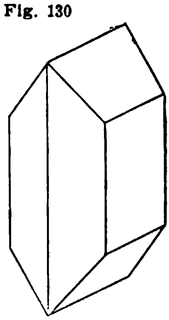


Fig. 134

As in the case of the prisms there are macro and brachy pyramids bearing relations to the unit pyramid analo-

gous to those described under the prisms. Some combinations in this group, which includes many important species, are shown in fig. 128–34.

Hemimorphic group

The comparatively few species crystallizing in this group occur in forms which are symmetric to two planes of symmetry passing through the basal axes and intersecting in the vertical axis which is an axis of binary symmetry. The two extremities of the vertical axis are not modified in the same way, giving a different termination to the two extremities of the crystal. The crystal of calamin shown in fig. 135 gives a good example of this type.

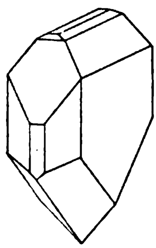


Fig. 135

Monoclinic system

Crystal forms in the monoclinic system are referred to three unequal uninterchangeable axes, two of which are inclined at an angle to each other, the third being perpendicular to the plane of the other two. The inclined axis which is placed vertical is designated by *c*, the other inclined axis by *a* and the normal or orthodiagonal axis by *b*.

A monoclinic crystal is represented conventionally with the orthoaxis (*b*) extending from right to left and the clinoaxis (*a*) dipping downward from back to front, the acute angle between the vertical and clino axes being designated by β (fig. 136). The statements regarding axial ratio under the discussion of the orthorhombic system apply in the case of monoclinic species with the additional note that the angle β varies for every species and constitutes one of the factors to be determined.

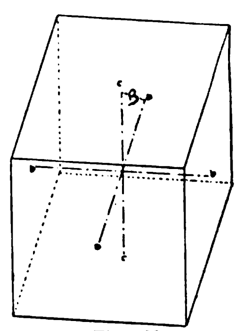


Fig. 136

Normal group

Forms of the normal group are symmetric to one plane of symmetry, which is the plane of the clino and vertical axes, and to one axis of binary symmetry, which is the orthoaxis (fig. 137).

Pinacoids. As in the normal group of the orthorhombic system, the monoclinic pinacoids are parallel to two axes and consist of pairs of parallel planes.

The basal pinacoid is parallel to both basal axes *a* and *b*.

The clinopinacoid is parallel to the clino and the vertical axis.

The orthopinacoid is parallel to the ortho and the vertical axis.

Fig. 136 shows the intersection of these three pinacoids.

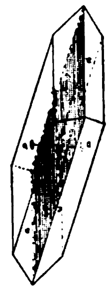


Fig. 137

Prisms. The monoclinic or inclined rhombic prism cuts both horizontal axes and is parallel to the vertical axis. The clino and ortho prisms of this group are entirely analogous, in their relations to the unit prism, to the macro and brachy prisms of the preceding system. Fig. 138 shows an inclined rhombic prism terminated by a basal pinacoid.

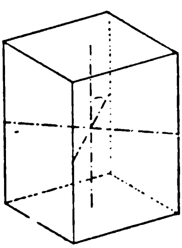


Fig. 138

Domes. The clinodome (fig. 139) consists of four faces parallel to the clinoaxis cutting the ortho and vertical axes; the faces are parallel in opposite pairs. The four faces which are parallel to the orthoaxis and intersect the other two, by reason of the lack of symmetry constitute two pairs of planes which

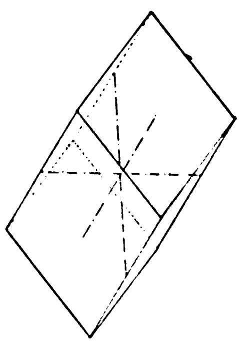


Fig. 139

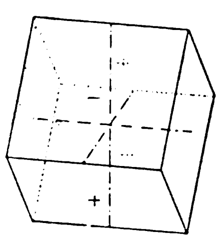


Fig. 140

are known as hemiorthodomes, the planes lying in the acute angle β being known as plus and those in the obtuse angle as minus. The plus and minus hemiorthodomes are shown in fig. 140.

Pyramids. For the same reason that the above mentioned faces are hemiorthodomes, the monoclinic forms which cut all three axes are hemipyramids. Faces in the acute angle β are plus hemipyramids and those in the obtuse angles are minus

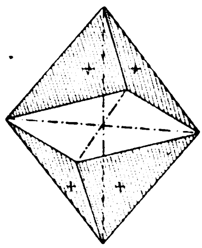


Fig. 141

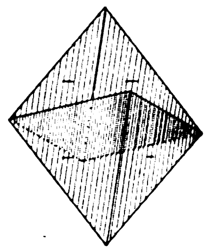


Fig. 142

hemipyramids (fig. 141, 142). As in the case of the prisms there are unit, ortho, and clino hemipyramids.

Some combinations in the group are given in fig. 143–148.

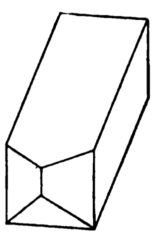


Fig. 143

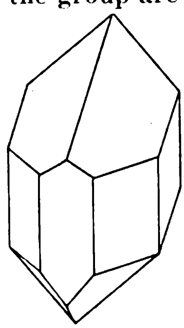


Fig. 144

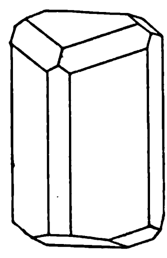


Fig. 145

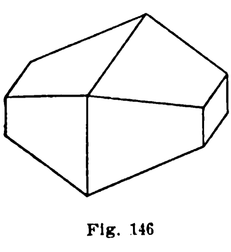


Fig. 146

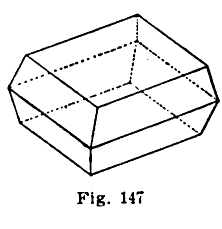


Fig. 147

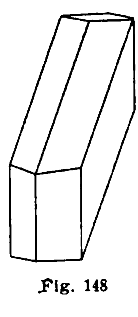


Fig. 148

Triclinic system

The least symmetric of the six systems includes all forms which are referable to three unequal uninterchangeable axes

all of which are inclined to one another. The axes are designated as in the orthorhombic system. The angle between *b* and *c* is called *α*, that between *a* and *c*, *β* and that between *a* and *b*, *γ*. These angles are distinct for every triclinic species (fig. 149).

The similarity in molecular structure between minerals of the orthorhombic, monoclinic and triclinic systems indicated by their crystallization is further accentuated by their optical properties, crystals of all three systems being optically biaxial; that is, there are two directions in which polarized light is transmitted through them without double refraction. Lines bisecting the angle between these optic axes bear a close relation to the symmetry and outward form of the crystal.

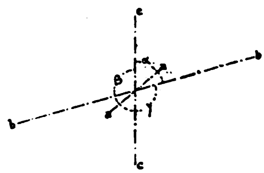


Fig. 149

Normal group

Crystals occurring in this group are symmetric only to a center, which is the point of intersection of the crystallographic axes. This symmetry admits of forms occurring only in the pairs of faces;[1] thus all prismatic and dome forms which in the orthorhombic system are represented by four faces here occur as hemiprisms and hemidomes, two faces alone being required to satisfy the symmetry of the class. Similarly, pyramidal

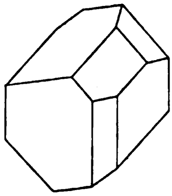


Fig. 150

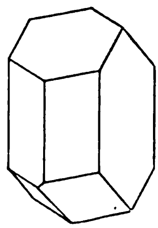


Fig. 151

forms which in the orthorhombic system consisted of eight faces are replaced by four complementary forms each consisting of two parallel planes. Compare model 11, which shows a triclinic or doubly inclined rhombic prism. With the above exceptions

[1] See p. 10, fig. 21.

the forms are identical in nomenclature with those of the orthorhombic system.

Two examples of triclinic crystals are shown in fig. 150 and 151 which represent respectively axinite and albite.

Variations in form

Reference has been made (p. 13) to the variations between the mathematical development of a crystal form or combination of forms and the actual mineral, crystallizing in those forms, as it is found in nature. This distortion is often misleading to a beginner, cubes and other forms of the isometric system being frequently elongated in the direction of one axis to such an extent as to resemble crystals of the tetragonal, the orthorhombic or even the hexagonal system. The reader is advised to observe carefully crystals of known minerals and to bear constantly in mind the symmetry of the group to which they belong.

Crystals of mineral species from the same locality show a predominance of one or two forms, which gives to such crystals a distinguishing character known as crystal habit. Minerals which occur widely distributed often show great variety in crystal habit, producing forms which are of great interest and beauty; quartz and calcite are notable examples.

Grouping of crystals

Though the crystals of many minerals occur isolated and developed alike on all sides, having somewhat the regularity of the ideal representations, it is far more common to find them grouped together in clusters, lining the interior of cavities, springing from the accompanying rock or lying embedded in the matrix. In some species the crystals show a tendency to arrange themselves in pairs, the faces of one individual being symmetrically disposed with respect to the other but in reverse position. This intergrowth of like crystals produces what is known as a twin crystal, the resulting solid being frequently of considerable complexity. A twin crystal may be recognized by reentrant angles which distinguish it from a simple crys-

1 Quartz, New Baltimore N. Y.

2 Calcite, Fontainebleau, France

tal, all the dihedral angles of which slope outward. A twinned octahedron is shown in fig. 152; the penetration twin cube, common in fluorite is shown in fig. 153 (compare also pl. 18_1); a scalenohedron of calcite twinned parallel to the basal plane is

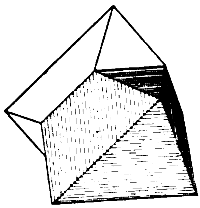


Fig. 152

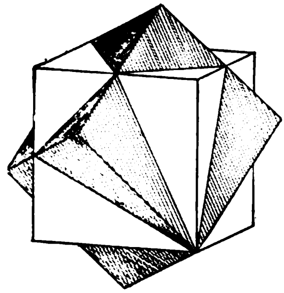


Fig. 153

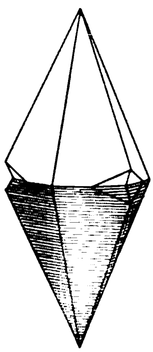


Fig. 154

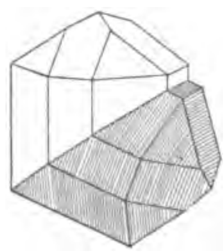


Fig. 155

shown in fig. 154, and a tetragonal twin of cassiterite in fig. 155. Aggregations of crystals frequently occur grouped in parallel position as shown in pl. 1_1.

Surface irregularities

Surface irregularities, occurring as they do on like faces of some crystals, often constitute a valuable means of determining the symmetry and consequently the group and system. Such markings on the faces of pyrite have been noticed in a former paragraph.[1] They are due in general to various causes which interrupt the perfect growth of the individual, producing low parallel furrows called striae or striations, angular depressions or prominences and dull faces. Curved faces are sometimes produced, as in the case of diamond.

[1] See p. 16.

Inclusions

Foreign bodies inclosed within a crystal are described under the general name of inclusions. They may be solid, liquid or gaseous in nature and organic or inorganic in origin. In general, inclusions result from rapid crystallization, as in the case of the calcite crystals shown in pl. 1_2; these show the typical rhombohedron of calcite, though containing a large percentage of the quartz sand carried by the solution from which they were crystallized.

Crystalline aggregates

Under this head are included the great majority of mineral specimens made up of aggregates of imperfect crystals. Many masses of material which appear to have no crystalline structure can be proved by optical and other physical tests to be composed of crystalline grains.

1 **Columnar structure.** Minerals possessing a columnar or fibrous structure present the appearance of bundles of slender columns.

parallel columnar, example beryl, pl. 2_1
bladed, example cyanite, pl. 2_2
fibrous, example serpentine (chrysotile) pl. 3_1

2 **Lamellar structure.** The mineral is composed of layers or leaves.

curved lamellar, example talc, pl. 3_2
foliated or micaceous, example muscovite, pl. 4_1

3 **Granular structure.** The crystalline particles consist of angular grains of about the same size.

coarse granular, example magnetite, pl. 4_2
fine granular, example dolomite (marble), pl. 5_1

4 **Imitative shapes.** The arrangement of masses of imperfect crystals often give rise to forms which resemble those of animate nature. The most important terms used to describe such forms are:

reniform, kidney-shaped, example hematite, pl. 5_2
botryoidal, composed of globular individuals resembling a bunch of grapes, example quartz (chalcedony), pl. 6_1

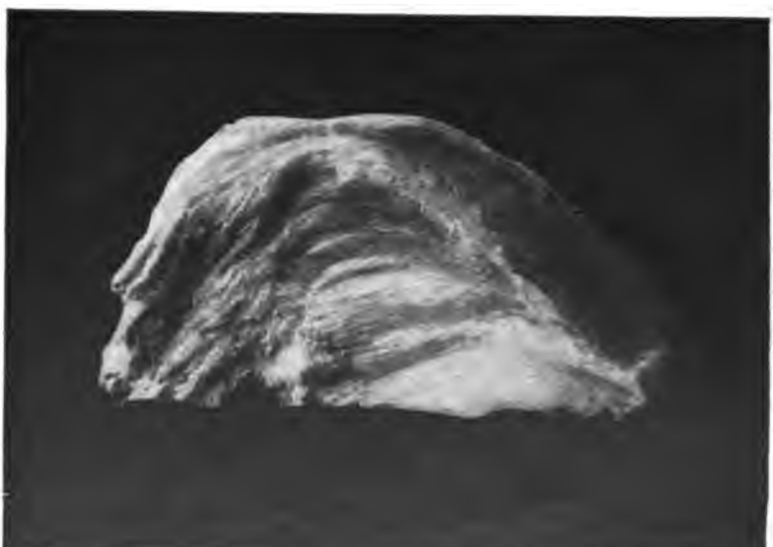
1 Beryl, Acworth N. H.

2 Cyanite, Litchfield Ct.

Plate 3

To face p. 40

1 Serpentine (chrysotile), Danville, Quebec



2 Talc, Smithfield R. I.

1 Muscovite, Stony Point N. C.

2 Magnetite, Mineville N. Y.

Plate 5 To face p. 40

1 Dolomite, Dover, Dutchess co. N. Y.

2 Hematite, Cleator Moor, England

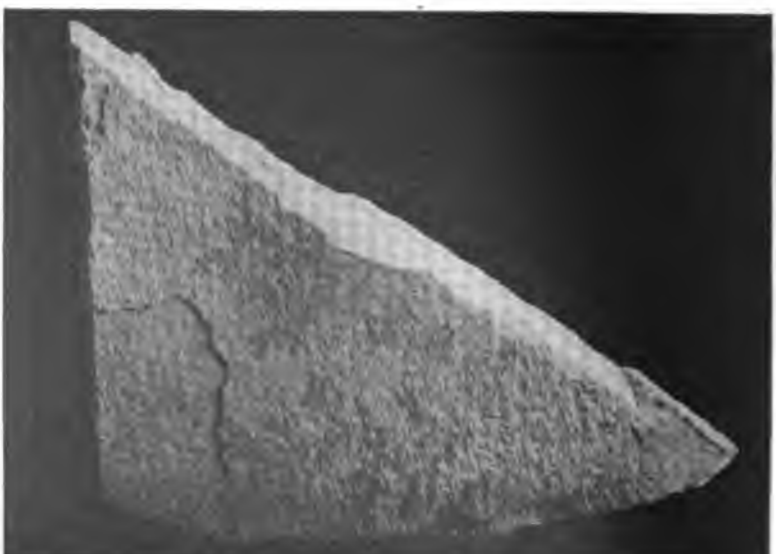
1 Quartz (chalcedony), Rocky mountains

2 Malachite, Bisbee Ariz.

1 Pectolite, West Paterson N. J.

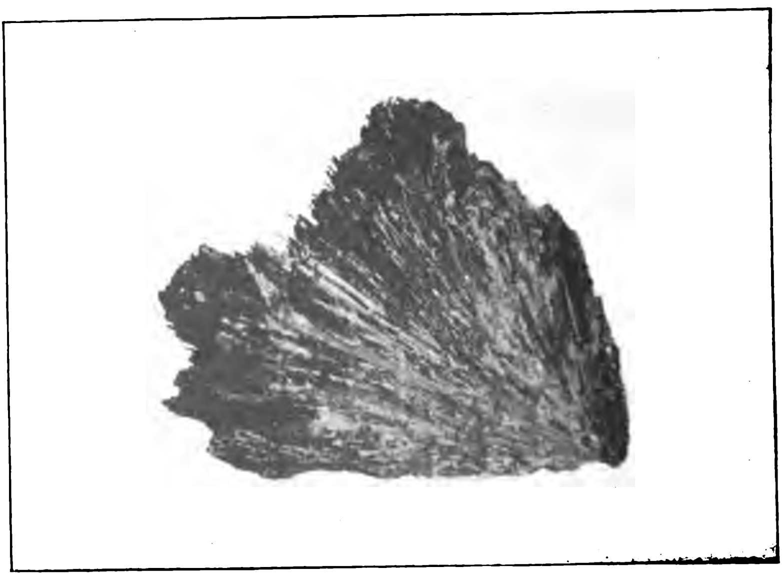
2 Calcite (pistolite), Karlsbad, Bohemia

1 Aragonite (flos ferri), Dubuque Ia.



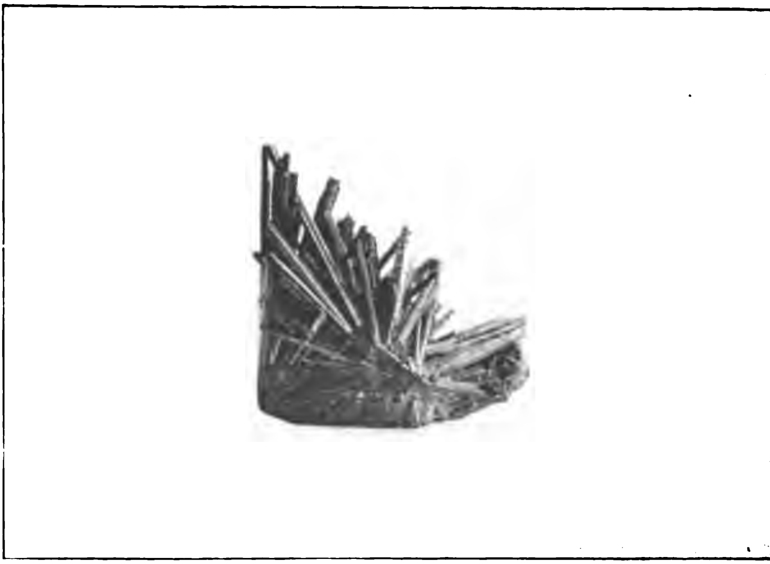
2 Pyrolusite (dendrite) Middle Granville N. Y.

1 Calcite (stalagmite), Howes Cave N. Y.



2 Stibnite, Felsöbánya, Hungary

1 Millerite, Antwerp N. Y.



2 Stibnite, Kremnitz, Hungary

mamillary, like the botryoidal but composed of larger and flatter protuberances, example malachite, pl. 6_2

globular, imperfect spheres of radiating fibers, examples wavellite, pectolite, pl. 7_1

oolitic, composed of small rounded grains, like the roe of fish, example calcite, pl. 7_2

coralloidal, consisting of branching forms like coral, example aragonite, pl. 8_1

dendritic, in branching treelike forms, example pyrolusite, pl. 8_2

stalactitic, in pendant columns from the roofs of caves, formed by percolation of water carrying dissolved material, example calcite, limonite, pl. 9_1

acicular, slender, needlelike forms, example stibnite, pl. 9_2

capillary, hairlike, example millerite, pl. 10_1

reticulated, interlaced fibers like a net, example stibnite, pl. 10_2.

Cleavage

Closely related to the crystalline structure of a mineral is the tendency, common in a varying degree to most mineral species, to break or split parallel to certain crystallographic planes. This tendency, which is called cleavage, takes place along the lines of minimum cohesion. Thus in a cube, the molecular arrangement of which is shown in fig. 2, it would be reasonable to expect cleavage to take place along planes parallel to the cube faces, that is, along the planes of molecular crowding. In fig. 156, assuming the dots to represent the position of molecules, the lines of least resistance to cohesion and consequently the lines of cleavage would be the vertical and horizontal rather than either of the inclined lines because the parallel lines of molecules on either side of the vertical and horizontal directions are further apart and consequently the attractive force between adjacent molecules would be least along these lines.

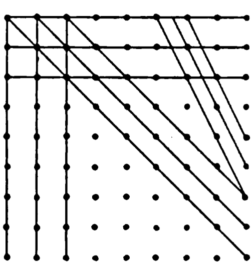


Fig. 156

In isometric minerals cleavage takes place parallel to the

faces of the cube, octahedron or dodecahedron. A good example of cubic cleavage is presented by the specimen of galena shown in pl. 11_1.

Tetragonal and hexagonal minerals show basal, prismatic or more rarely pyramidal cleavage. Rhombohedral cleavage is common among minerals crystallizing in the rhombohedral division of the hexagonal system. The rhombohedral cleavage of calcite is shown in pl. 11_2.

In the orthorhombic system cleavage parallel to one or more pinacoids is common, also prismatic cleavage. Clinodiagonal cleavage, parallel to the clinopinacoid, is found in many monoclinic species; also basal and prismatic cleavages and occasionally cleavage parallel to the hemipyramids as with gypsum.

In the triclinic system it is customary to select the axes so as to make the cleavage directions parallel to the pinacoids.

The parallel planes produced by cleavage may sometimes be advantageously observed by holding the specimen so as to reflect the light from a prominent face, and noting how the cleavage faces, previously hidden by the rough surface of the specimen, catch and reflect back the light. Cleavage is also evidenced by reflections from the interior of the crystal, incipient cracks and many other traces which appeal to the eye of a trained observer.

Fracture

The fracture of a mineral is observed on a broken surface other than a cleavage plane. It may be:

1 conchoidal, with a smooth, curved surface like broken glass or porcelain;

2 even, with more or less regular depressions and elevations;

3 uneven, with a rough, irregular surface;

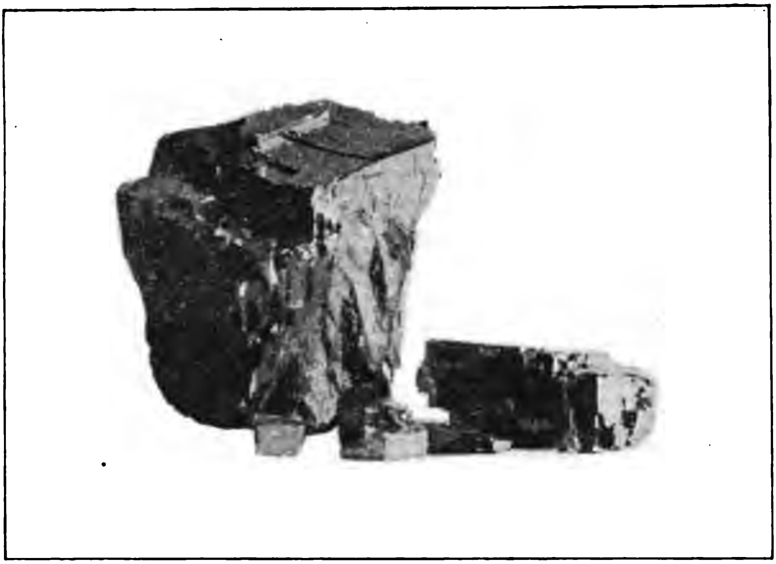
4 hackly, with sharp, jagged elevations like broken iron.

Hardness

The degree of resistance offered by the smooth surface of a mineral to abrasion is known as hardness. A relative scale of hardness of 10 common minerals is arranged as follows:[1]

1 talc	3 calcite (crystallized)
2 gypsum	4 fluorite

[1] This scale of hardness was introduced by Mohs and is now generally accepted.



1 Galena, Rossie N. Y.

2 Calcite, Glenville, Schenectady co. N. Y.

5 apatite
6 orthoclase
7 quartz (rock crystal)
8 topaz
9 corundum
10 diamond

A sharp corner of the mineral to be tested for hardness is rubbed across the surface of each successive member of the scale, beginning with the high members, till one is found which is distinctly scratched; the hardness thus determined lies between that of the scale mineral scratched and the next higher member; thus, a mineral which scratches calcite but does not scratch fluorite has a hardness of 3–4. A good knife will scratch 6 with difficulty.

Tenacity

A mineral may be:

1 brittle, when it falls to powder before a knife or hammer and can not be shaved in thin slices;

2 sectile, when it can be shaved in thin slices but falls to powder under the hammer;

3 ductile, when slices shaved from it may be flattened under the hammer;

4 flexible, when it will bend without breaking.

Characters depending on light

Luster

Differences in the luster of minerals are due to the light which is reflected from the surface; luster is independent of the color of the mineral. The luster of a mineral may be:

1 metallic, the luster exhibited by opaque metals, example pyrite;

2 adamantine, the oily luster of the uncut diamond, example cerussite;

3 vitreous, the luster of glass, example quartz;

4 resinous, the luster of yellow resin, example sphalerite;

5 greasy, the luster of oiled glass, example elaeolite;

6 pearly, the luster of the mother of pearl, example brucite;

7 silky, the luster of silk produced by a fibrous structure, example satin spar;

8 dull, void of luster, example kaolin.

Color

The color of a mineral is a matter of considerable variation, different specimens of the same species frequently differing through quite a wide range. This is notably so of the minerals of nonmetallic luster, as in the case of fluorite, which is found in white, yellow, green, rose-red, violet, blue, brown, wine color and greenish blue varieties. Metallic minerals are far more constant in color, a fresh fracture ordinarily giving the characteristic color of the species.

The color of the fine powder of a mineral is known as its streak and often differs from the color of the hand specimen. With soft minerals it may be readily obtained by rubbing the specimen on a piece of unglazed porcelain.

General principles of chemical classification

A substance which can not be decomposed or separated into simpler constituents is known as an element. About 70 such elements are recognized at present, less than half of which are of common occurrence. It is estimated[1] that 99% of the solid crust of the earth for a depth of 10 miles is composed of eight elements as follows:

oxygen	47.3%	calcium	3.8%
silicon	27.2	magnesium	2.7
aluminium	7.8	sodium	2.4
iron	5.4	potassium	2.4

For convenience elements are represented in chemical formulas by symbols which consist of the initial letter of the name of the element or an abbreviation composed of two letters, thus:

P=phosphorus	Na=sodium (natrium)
S=sulfur	Ca=calcium
O=oxygen	Pb=lead (plumbum) etc.

In the appendix will be found a table giving the names of the elements, their symbols and their relative atomic weight. Some elements occur native or alone in nature, such as gold, silver, copper, carbon, sulfur, etc. but the great majority of

[1] Clarke, F. W. Relative abundance of the chemical elements. Phil. soc. of Washington. Bul. 9. 1889. p. 138.

mineral species are compounds of two or more elements united according to the laws of chemical combination.

A few predominant chemical compounds make up the greater part of the earth's crust. Of these, silica (SiO_2), a combination of silicon and oxygen, is the most important. This forms quartz and its numerous varieties, amethyst, agate, flint, etc.; and, combined with other elements, often with an extremely complicated chemical composition, silica makes the great group of silicates, which includes the larger number of the common rock forming minerals. Oxygen combined singly with an element forms another great group, the oxids to which many ores, such as those of iron, belong. Combined with aluminium oxygen forms alumina (Al_2O_3), a common mineral; and this combined with silica is the base of our clays and an important rock constituent. Oxygen with carbon and some other elements forms the carbonates to which limestone belongs; with sulfur and some other elements it forms the sulfates (gypsum, etc.); and with phosphorus and another element the phosphates. Sulfur, without oxygen, combined with an element forms a sulfid, fluorin a fluorid, chlorin a chlorid, etc.[1]

The most satisfactory classification of mineral species is that based on chemical composition. Under sections having a similar chemical composition, species are divided into groups which usually embrace minerals closely allied crystallographically. Throughout the succeeding section the chemical composition of each species is given in words and symbols, which, while appealing specially to the chemist, can be readily understood by those who bear in mind that in each mineral those elements are found whose abbreviations appear in the symbol. Numbers below the sign indicate the relative number of atoms of each element. Example, realgar is a sulfid of arsenic, and the signs of sulfur (S) and arsenic (As) appear in its symbol (AsS); or, there is one atom of sulfur and one of arsenic united, but arsenic is relatively heavier than sulfur (see table of elements in appendix) therefore the composition by weight is in percentages: sulfur, 29.9; arsenic, 70.1; 100.

Isomorphism, dimorphism, etc.

It has been found in a number of cases that mineral species so related by chemical composition as to form part of one of the

[1] Tarr, Ralph S. Economic geology of the U. S. 1894.

mineralogic divisions, such as carbonates, oxids, silicates, etc. also present a strikingly close similarity in the arrangement of their molecules as shown by their crystallization, cleavage and optical properties; minerals so related are said to form an isomorphous group.

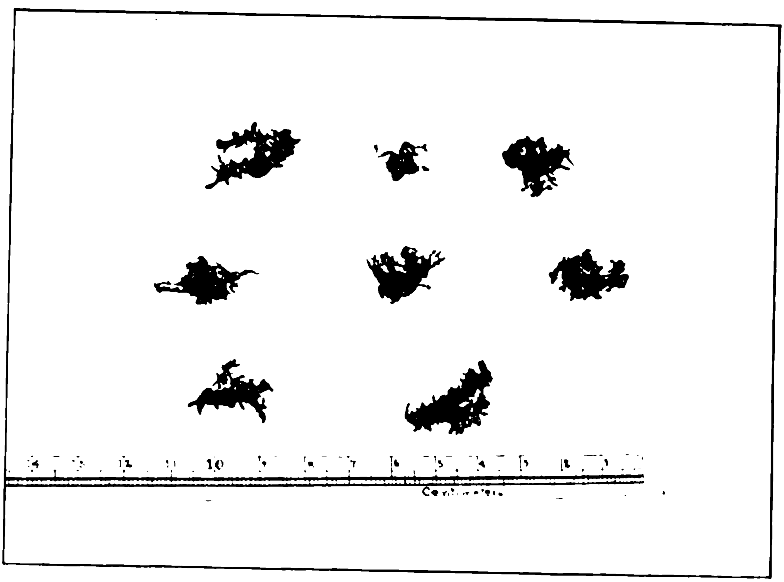
In some instances a combination of elements occurs crystallized in two or more series of crystal forms which are notably separate and distinct and frequently present the symmetry of different systems; this gives rise to two (sometimes three) species of identical chemical composition and is known as dimorphism (or trimorphism where three species are concerned). A very good example of dimorphism is presented by the carbonate of calcium, which crystallizes in the rhombohedral group of the hexagonal system as the mineral calcite and in orthorhombic forms as the mineral aragonite. Calcite stands at the head of an isomorphous group of carbonates which all crystallize in very closely related rhombohedral forms. Similarly aragonite represents an isomorphous group of orthorhombic carbonates which agree very closely in axial ratios and crystal habit.

Pseudomorphs

Not uncommonly the composition of a crystallized mineral will undergo some change by reason of the addition, loss or replacement of one or more elements. Thus pyrite, which is a sulfid of iron, may, under certain conditions, undergo a change of composition, the sulfur being replaced by oxygen and some water and the resulting mineral will have the composition of limonite. This change is *not* accompanied by a corresponding change in external form, therefore the altered substance will present the crystallization and structure of the original mineral but the composition, color, luster and hardness of the mineral to which it has altered. Such a product of alteration is called a pseudomorph. In the above instance limonite is said to form a pseudomorph after pyrite.

To face p. 47

1 Diamond, Kimberley, South Africa



2 Silver, Freiberg, Saxony

PART 2

DESCRIPTION OF MINERAL SPECIES

NATIVE ELEMENTS

Native elements are divided into two groups, metals and nonmetals; between these two is inserted a series of semimetals which partake, sometimes of the nature of the metals and sometimes of the nature of the nonmetals.

NONMETALS

Diamond, carbon C

Diamonds are usually found in isolated, rounded, isometric crystals, octahedrons or modified octahedrons (pl. 12_1). They are transparent, with an adamantine luster, like oiled glass, and are commonly colorless or faintly tinted.

The diamond is the hardest substance known; this, together with its high refractive power and easy octahedral cleavage, renders it particularly suited for a gem stone, while the comparative rarity of unflawed crystals and the difficulty experienced in cutting them owing to their extreme hardness, combine to make diamonds objects of considerable value. Massive and impure varieties are used for abrasive materials and in such cutting machinery and tools as require very hard edges. These massive varieties are known as bort and carbonado. Bort consists of rounded forms of confused crystalline structure. Carbonado is a black, massive form without cleavage.

Diamonds occur chiefly in alluvial deposits of gravel, sand or clay, the associated minerals being those common to granitic rocks. Diamonds were formerly extensively obtained from India, which has produced many remarkable gems; later they were discovered in Brazil, but the present great diamond producing region is South Africa.

Graphite, carbon C

Like the diamond, graphite is composed of carbon sometimes containing iron, clay, sand or other impurities. It occurs in soft black flakes or scales which are rarely hexagonal in shape.

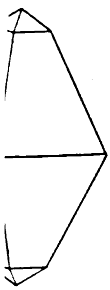
basal cleavage, splitting into plates which are
;htly sectile, its luster is metallic and its color

ırs in beds and as embedded grains in granite,
ist and crystalline limestone. It is quite widely
oughout New York, appearing notably at Hague
ılity a large proportion of the American output

ısed largely in the manufacture of crucibles and
y vessels, in the so called "lead" pencils and for
rposes.

Sulfur S

und in orthorhombic pyramids as in fig. 157, or
of the same, fig. 158, the crystals are often trans-
the Sicilian variety extremely beautiful. Sulfur
massive, reniform, stalactitic, incrusting other



g. 157

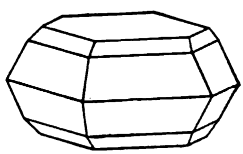


Fig. 158

Sulfur

in the varieties found near hot springs and in
powder. The color is commonly a lemon-yellow
uently shades into yellow orange, brown or gray.
resinous and the streak white. Sulfur is found
regions of active or extinct volcanic action, as a
ıot springs and as a product of the decomposition
l sulfates. It occurs in large deposits in the
:; it is also distributed to some extent throughout
art of the United States and has been known to
y near the sulfur springs of New York.
ed in large quantities in the manufacture of sul-
powder, matches etc.

SEMIMETALS

Arsenic. Arsenic is usually found in massive forms, the structure being reniform, and is composed of concentric layers which can frequently be separated with ease. Crystals are quite rare. The color is tin-white, tarnishing to black, and the luster is nearly metallic. It occurs in veins in crystalline rocks and in the older schists.

Antimony. Usually found in massive forms, lamellar or radiated, of a tin-white color and metallic luster. Rhombohedral crystals are of rare occurrence.

Bismuth. Bismuth is found in brittle, silver-white, arborescent forms which, on a fracture of the ground mass, resemble Hebrew characters; also foliated and granular. The luster is highly metallic and the color white, sometimes taking a reddish tinge. It is rarely found in distinct hexagonal crystals.

METALS

Gold Au

Gold is usually found alloyed with small amounts of silver and sometimes copper and rare metals. Distinct isometric crystals are rare though skeleton crystals and distorted octahedrons in wirelike, arborescent and reticulated shapes are quite common. Nuggets, grains and scales are also characteristic, usually disseminated through the gold-bearing rock in such small quantities as to be perceptible only by assay methods. It is of a fine yellow color, has a metallic luster and is extremely malleable and ductile.

Gold occurs in veins, usually in quartz rock, where it is associated with sulfids, specially pyrite. It is largely mined from superficial deposits of sand, gravel and boulders formed in the valleys and river bottoms from the erosion of higher rocks containing gold veins. These beds of gold-bearing material are called placers.

Gold is used chiefly for coinage, jewelry and gilding.

Silver Ag

ature quite pure though sometimes alloyed
l other metals. Isometric crystals are of
it occurrence than in the case of gold;
cubes are quite common; these pass into
l wirelike forms similar to those shown in
soft, malleable metal, silver-white on the
rnishing to dark gray or black.
ins traversing gneiss, schist, porphyry and
so associated with copper in calcite. It is
small amounts by galena. Some of the
ilities where it is found are Kongsberg,
ru; northern Mexico; also Michigan, Col-
na and Arizona. An unsuccessful attempt
vicinity of Ossining was made early in the

nuch the same purposes as gold.

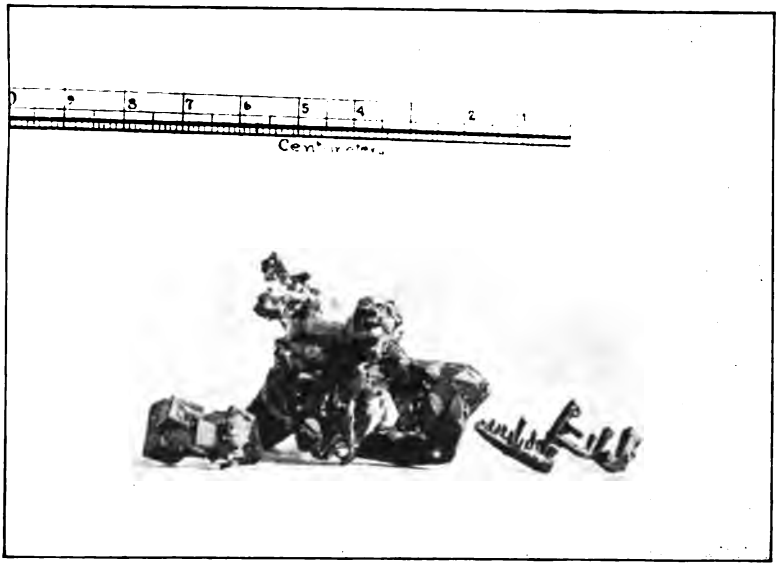
Copper Cu

oft, red, malleable crystals of the isometric
l masses and sheets. The common crystal
forms are the cube and tetrahexahedron
alone or in combination as shown in
fig. 159; distorted and twisted crystals
pass from parallel groups to branching
arborescent forms (pl. 13_2). Twins are
quite common but are, however, almost
invariably distorted. The luster is metal-
lic and the color and streak red, the
ed nearly black.
beds and veins with native silver and the
and is frequently found near dykes of
e Lake Superior region in northern Michigan
and sandstone associated with calcite, dato-

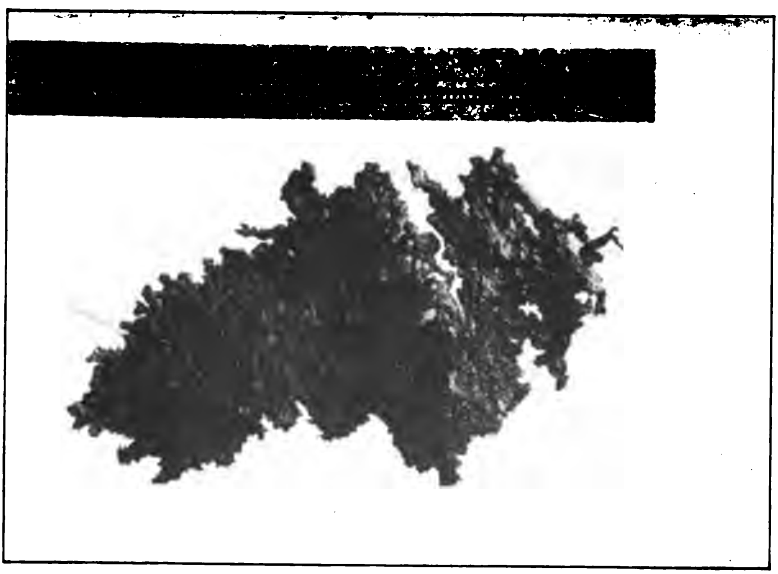
used in electric work and in alloys such as
etal, German silver, etc.

Plate 13

To face p. 50



1 Copper, Lake Superior, Mich.



2 Copper, Yadkin gold mine, N. C.

Mercury Hg

Mercury is remarkable as being almost the only mineral occurring in the liquid state. It is found in small white metallic globules scattered through its gangue, which is usually its own sulfid, cinnabar.

It occurs chiefly in clay shales and schists.

Platinum Pt(Fe)

Platinum as it occurs in nature is almost invariably alloyed with iron and usually with small quantities of the rarer metals. It is found in small malleable grains or nuggets of a steel-gray to white color scattered through alluvial sand and associated with gold. It is often mined with the gold from these placer deposits.

A large proportion of the production of platinum is taken from the placer deposits of the Ural mountains. It is also known to occur in Borneo, Brazil and the United States of Colombia.

Platinum is practically infusible and is consequently used to a large extent for chemical apparatus which is required to resist a high degree of heat.

Iron

See under meteorites.

SULFIDS, SELENIDS, TELLURIDS, ARSENIDS, ANTIMONIDS

SULFIDS, ETC. OF THE SEMIMETALS

Realgar AsS

Realgar is a monosulfid of arsenic. It occurs in translucent, orange-red granular masses with a resinous luster, also in transparent monoclinic crystals, which are short prismatic in habit and are striated vertically.

Realgar is found in Hungary and in the island of Borneo; it also occurs in Utah, California and Wyoming. It is used as a pigment.

Orpiment As_2S_3

Orpiment is the trisulfid of arsenic. It sometimes occurs in imperfect orthorhombic crystals but more generally in foliated or columnar masses of a brilliant lemon-yellow. When foliated

dily separated into thin, flexible, nonelastic scales. soft (H-1.5-2), slightly sectile and has a resinous or

.

n found associated with realgar. The principal e Hungary, Borneo, Turkey; also Wyoming, Utah It is found in the form of powder at Edenville

Stibnite (antimony glance) Sb_2S_3

the trisulfid of antimony containing sulfur 28.6%, 4%.

l in orthorhombic crystals of prismatic habit; a nation is shown in fig. 160. The crystals, which y acicular, show a tendency to arrange themselves in radiating and reticulated groups (pl. 9_2, 10_2). They are grooved and striated vertically and are sometimes bent and twisted. The color and streak are lead-gray and the luster metallic with brilliant reflecting surfaces. Stibnite is quite soft. the hardness being about 2, and has an easy cleavage parallel to the vertical axis. It often occurs in massive forms coarse or fine columnar and sometimes granular.

curs in Hungary, Japan and New South Wales; da, Idaho, Utah, California, Arkansas and Nova

the chief source of antimony and is also used vely in the production of safety matches, perfireworks and rubber goods, and in the refining

SULFIDS, ETC. OF THE METALS

Galena (galenite, lead glance) PbS

ant mineral is the sulfid of lead, containing sulfur 86.6%.

crystallized and massive and is characterized by a cubic cleavage (pl. 11_1). The crystals, some of own in fig. 161–63 are isometric, the cube and eing the prevailing forms. The crystal group 4_1, gives some idea of the crystal habit and irreg-

Plate 14 To face p. 52

1 Galena, Galena Ill.

2 Chalcocite, Bristol Ct.

ular grouping. Distorted crystals are frequent, as in the specimens from Gonderbach, Nassau (N. Y. state museum collection). Twin crystals are also common. Galena is lead-gray in color and streak; it is soft (H=2.5) and very heavy. The luster is

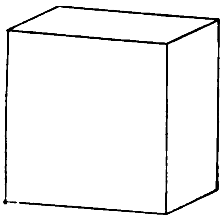


Fig. 161

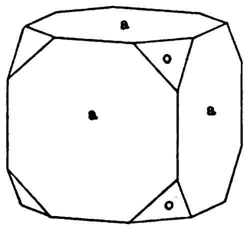


Fig. 162

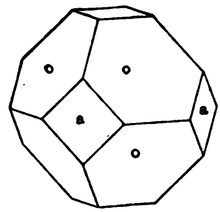


Fig. 163

Galena

metallic and bright on a fresh fracture but apt to become dulled and oxidized on crystal faces which have been long exposed.

Galena is very widely distributed. It occurs in veins in crystalline and noncrystalline rocks and is commonly associated with other sulfids and other salts of lead, which latter are frequently the result of its alteration. In addition to numerous and important foreign localities it occurs in the United States in extensive deposits in Missouri; also in Illinois, Iowa, Wisconsin, and in New York at Rossie, St Lawrence co., Ellenville, Ulster co. and Wurtzboro, Sullivan co.

Galena is the principal ore of lead and is extensively worked in Colorado, Idaho, Montana and other western states for the silver it usually contains.

Argentite (silver glance) AgS

The sulfid of silver contains 12.9% sulfur and 87.1% silver.

The crystals are isometric, of an octahedral habit, and are often modified by the cube; distorted forms are quite common as are parallel groupings which produce arborescent forms. It also occurs massive. Argentite is soft and sectile; it has a lead-gray color and metallic luster.

It occurs at Freiberg, Germany; in Hungary, Norway, Cornwall, Peru, Chile and Mexico. In the United States it is found in Nevada and Arizona and in the Lake Superior region of Michigan. It is mined for silver.

Chalcocite (copper glance) Cu_2S

Chalcocite is a copper sulfid containing 20.2% sulfur and 79.8% copper.

Though often occurring in orthorhombic crystals (pl. 14_2) chalcocite is more frequently met with in masses which somewhat resemble argentite but are much more brittle; it may be distinguished from bornite by the absence of the characteristic red-brown color peculiar to bornite. The luster is metallic and the streak and color lead-gray, the latter taking a dull black tarnish on exposure.

Chalcocite occurs commonly associated with other copper minerals. Beautiful specimens of this mineral are found in the Cornwall mines. It occurs also in Bohemia, Saxony, Mexico and South America. Interesting crystals are found at Bristol Ct., and massive varieties to considerable extent at Butte Mont.

Chalcocite is an ore of copper.

Sphalerite (zinc blende or blende) ZnS

The zinc sulfid known as sphalerite or blende contains 33% sulfur and 67% zinc.

Sphalerite often contains cadmium manganese and iron in small quantities. It crystallizes in the tetrahedral group of the

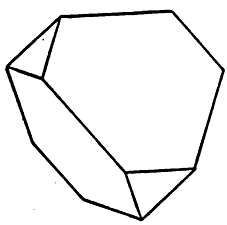


Fig. 164

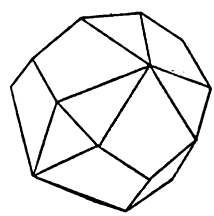
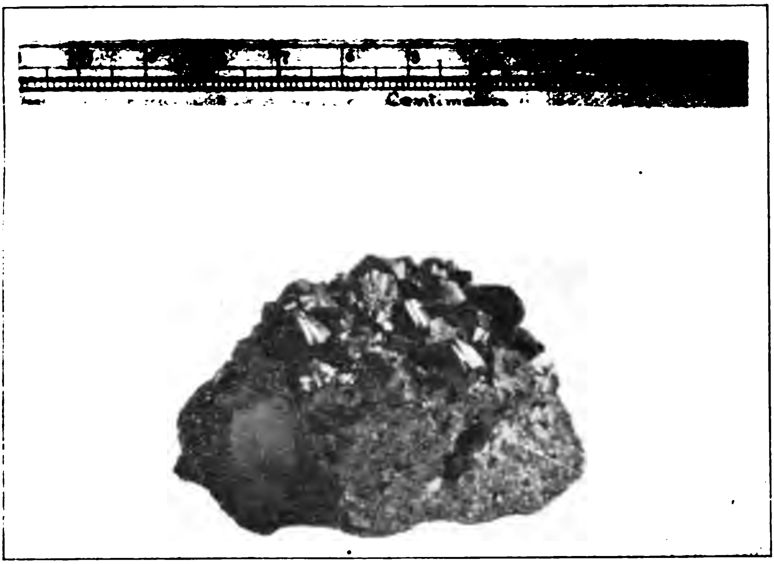


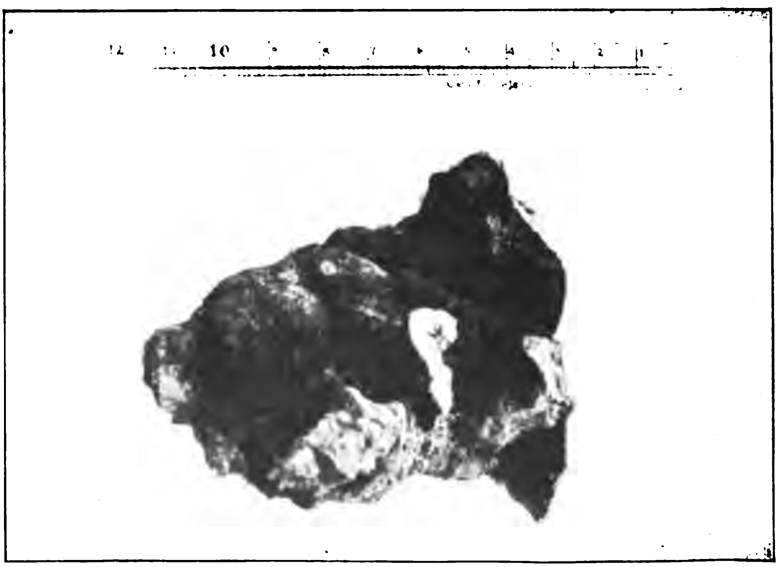
Fig. 165

Sphalerite

isometric system (fig. 164, 165). In specimens from some localities the modification of the dodecahedron shown in fig. 165 has a tendency by reason of repeated twinning to form a somewhat curved face as in the specimen shown in pl. 15_1. Massive varieties are very common and show a perfect dodecahedral cleavage. Compact masses of alternating layers of sphalerite and galena also occur. The color ranges from black through red, brown, yellow, green, to white, the more frequent shades being



1 Sphalerite, Joplin Mo.



2 Millerite, Gap mine, Lancaster co. Pa.

black, brown and yellow. The streak is yellowish brown to white and the luster resinous.

Sphalerite occurs in both crystalline and sedimentary rocks and is frequently associated with galena. Such an association is found in the extensive deposits of Missouri, Wisconsin, Iowa and Illinois. Sphalerite is found in several localities in England and Germany, also in Hungary, Sweden, Spain, etc. In New York it is found in small quantities in a number of places, notably at Wurtzboro, Sullivan co., Ellenville, Ulster co., at the Ancram lead mine in Columbia county, in the limestone of Lockport, Niagara co., and with calamin at Bethlehem Pa.

Besides being an important ore of zinc, sphalerite yields considerable cadmium.

Cinnabar HgS

The sulfid of mercury, cinnabar, contains 13.8% sulfur and 86.2% mercury.

The mineral is rarely found in hexagonal crystals of the rhombohedral-trapezohedral group; it is commonly met with in granular or earthy masses sometimes incrusting or as an earthy coating. Cinnabar is very heavy (G=8.–8.2); this and its brilliant red streak usually serve to identify it. The color is cochineal-red to reddish brown and sometimes even inclining to black; the luster is adamantine to dull.

Cinnabar occurs in a variety of rock formations, being found in slate, shale, granite and porphyry, where it is associated with other sulfids. The principal localities are Almaden, Spain, southern Russia, southern Austria, China, Peru, and Mexico. California furnishes most of the American output.

Cinnabar is a valuable ore of mercury and was formerly ground for a pigment called vermilion. The pigment is now produced artificially.

Greenockite CdS

Greenockite, the sulfid of cadmium, contains 22.3% sulfur and 77.7% cadmium.

It usually occurs as a bright yellow powder coating sphalerite and rarely in dull yellow hexagonal crystals of the hemimorphic group. The crystals are nearly transparent and of a resinous luster.

It is rarely found in distinct hexagonal crystals of tabular habit, the most common form of occurrence being as a massive metallic mineral of a bronze color possessing to a varying degree the property of attracting the magnet. It differs from pyrite, bornite and niccolite in color and in the magnetic property mentioned above.

Pyrrhotite occurs in gabbro and other igneous rocks and in schists; it is also found in meteorites. It is very widely distributed. The principal American localities are Sudbury, Can. and Lancaster Gap Pa. at both of which places it is mined for the nickel it contains. A deposit of pyrrhotite was formerly worked at Anthony's Nose, Westchester co. N. Y.

Bornite (purple copper ore)

Bornite is a sulfid of copper and iron of variable proportions, the massive variety being probably a mechanical mixture with chalcocite. The crystallized mineral seems to conform quite closely to the formula which gives 28.1% sulfur, 55.5% copper and 16.4% iron.

The crystallized specimens show isometric forms with a cubic habit. The massive varieties have a granular to compact structure. The mineral is characterized by a metallic luster and a dark copper-red, pinchbeck-brown or purple color which tarnishes rapidly to iridescence.

Bornite occurs associated with the other copper minerals in Cornwall (crystalline), Chile, Peru, Bolivia, Mexico and Canada and in the United States at Bristol Ct. and near Wilkesbarre Pa.

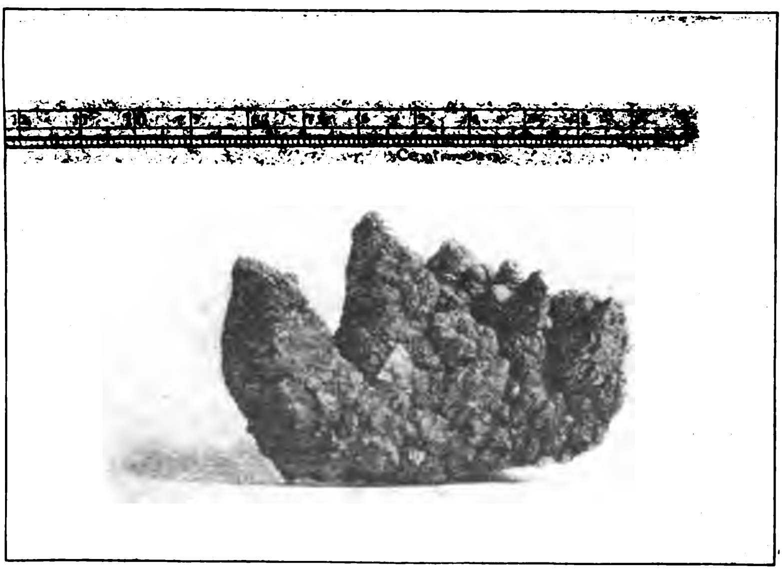
It is mined for copper.

Chalcopyrite (copper pyrites) $CuFeS_2$

Chalcopyrite is a sulfid of iron and copper in the proportions, 35% sulfur, 34.5% copper and 30.5% iron. Variations from these proportions are often due to pyrite mechanically intermixed in the massive varieties.

The tetragonal crystals of chalcopyrite belong to the sphenoidal group and when in simple, unmodified forms resemble isometric tetrahedral types. Modified crystals such as those given in fig. 166, 167, however, clearly show the true symmetry

1 Pyrite, Gilpin county, Col.



2 Marcasite, Galena Ill.

Pyrite deposits are worked for the production of sulfuric acid in Louisa county, Va., in the Rio Tinto region of Spain and in various other localities including one at Hermon, St Lawrence

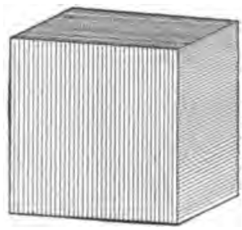


Fig. 168

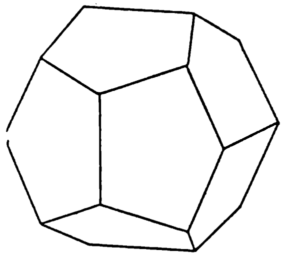


Fig. 169

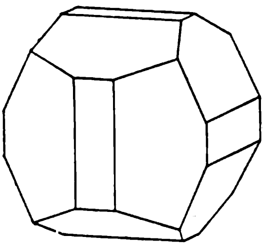


Fig. 170

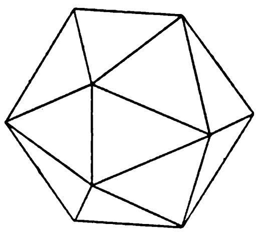


Fig. 171

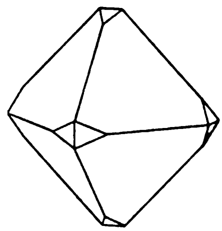


Fig. 172

Pyrite

co. N. Y. Sometimes gold and copper contained in small quantities in pyrite are recovered.

Smaltite, chloanthite $(CoNi)As_2$

The minerals of this group pass from one to the other by such insensible gradations that it is often impossible to separate them. Smaltite is essentially cobalt diarsenid containing 71.8% arsenic and 28.2% cobalt. Chloanthite is essentially nickel diarsenid and contains 71.9% arsenic and 28.1% nickel.

The crystals are similar to those of pyrite. The mineral usually occurs in tin-white to steel-gray metallic masses.

It occurs in veins with other ores of cobalt, nickel, copper and silver, notably in the Saxon and Bohemian localities. It is also found at Chatham Ct., Franklin N. J. and in California.

It is the main source of the cobalt products.

Cobaltite (cobalt glance) CoAsS

Cobaltite, the sulfarsenid of cobalt, contains 19.3% sulfur, 45.2% arsenic and 35.5% cobalt.

It resembles pyrite in crystallization and luster and is silver-white to gray in color.

Like smaltite it is a source of cobalt compounds.

Marcasite (white iron pyrites) FeS_2

Marcasite is the orthorhombic iron disulfid, and has the same composition as pyrite.

The dimorphism of iron disulfid is all the more interesting because pyrite represents an isomorphous group of sulfids and arsenids which crystallize in similar forms of the isometric system, and marcasite heads a similar isomorphous group crystallizing in closely related forms of the orthorhombic system.

Twins and crystalline aggregates are common, resembling spearheads, cockscombs, etc. often with radiated, stalactitic structure as in pl. 16_2. The color of marcasite is somewhat whiter than that of pyrite, which it closely resembles.

Marcasite occurs in Saxony, Bohemia and England, and in the United States, associated with sphalerite, at the zinc mines of Missouri, in Wisconsin and at Warwick, Orange co. N. Y.

It is used in the manufacture of sulfuric acid. It is also found in nodular concretions in the Tertiary and Cretaceous clays of Long Island and Staten Island.

Arsenopyrite (mispickel) FeAsS

Arsenopyrite is the sulfarsenid of iron and contains 46% arsenic, 34.3% iron and 19.7% sulfur.

Arsenopyrite crystallizes in the orthorhombic system in forms resembling marcasite. A common type of crystal is represented in fig. 173 and a characteristic grouping in pl. 17_1. Arsenopyrite commonly occurs in coarse to fine granular masses or disseminated grains. It is silver-white to gray, with a metallic luster.

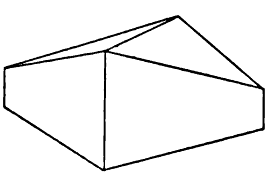


Fig. 173
Arsenopyrite

Arsenopyrite is found principally in veins in crystalline rocks associated with other metallic sulfids and arsenids. The deposits of New South Wales, California and Alaska occasionally carry some gold. It is found in many European localities,

1 Arsenopyrite and dolomite, Freiberg, Saxony

2 Halite, Great Salt lake, Utah

in Canada, in parts of New England and in Orange and Putnam counties, N. Y.

Arsenopyrite is an ore of arsenic.

Sylvanite (graphic tellurium) $(AuAg)Te_2$

Sylvanite represents a group of gold and silver tellurids which has recently developed to considerable importance in the Cripple Creek district of Colorado. Sylvanite contains 62.1% tellurium, 24.5% gold and 13.4% silver.

It occurs in flat monoclinic crystals usually grouped in branching forms resembling written characters, it is silver-white to steel-gray in color, inclining to yellow, and has a brilliant metallic luster.

Sylvanite occurs in Transylvania, California and Boulder county, Col. where it is mined for gold.

SULFO-SALTS

SULFARSENITES, SULFANTIMONITES, ETC.

Bournonite (wheel ore) $PbCuSbS_3$

Bournonite is a sulfantimonite of lead and copper and contains 42.5% lead, 13% copper, 24.7% antimony and 19.8% sulfur.

The orthorhombic crystals are frequently twinned, producing the "cogwheel" forms from which the species derives its common name. It frequently occurs massive, granular or compact. The color is steel-gray to dark gray and the luster metallic.

Bournonite is found in Germany, Bohemia, Hungary, Cornwall, Mexico, Chile; also in Canada, Arizona, Arkansas and Colorado.

Pyrargyrite (dark ruby silver ore) Ag_3SbS_3

Pyrargyrite is a sulfantimonite of silver and contains 17.8% sulfur, 22.3% antimony and 59.9% silver.

Pyrargyrite crystallizes in the rhombohedral-hemimorphic group of the hexagonal system. The crystals are prismatic with rather flat terminations and are frequently twinned. It is translucent to opaque, of a deep red color by transmitted light and gives a purplish red streak. The luster is metallic to adamantine.

Pyrargyrite is found in several German localities, in Mexico and Chile; also in Idaho, Nevada, Colorado and other silver bearing regions of the western states.

It is mined for silver.

Proustite (light ruby silver ore) Ag_3AsS_3

Proustite is a sulfarsenite of silver and contains 19.4% sulfur, 15.2% arsenic and 65.4% silver.

Proustite closely resembles pyrargyrite in crystallization as well as in translucency. Its luster is adamantine rather than metallic and it differs from pyrargyrite in the color, which shades more toward scarlet. The streak is scarlet.

Proustite is found associated with pyrargyrite, the localities being essentially the same as for that species.

It is a source of silver.

Tetrahedrite (gray copper ore) $Cu_8Sb_2S_7$

Tetrahedrite is a sulfantimonite of copper and contains 23.1% sulfur, 24.8% antimony and 52.1% copper. Some of the antimony is usually replaced by arsenic, which causes it to merge gradually into tennantite, the sulfarsenite of silver.

Tetrahedrite crystallizes in the tetrahedral group of the isometric system. The crystals, two of the commonest types

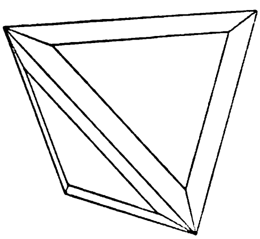


Fig. 174

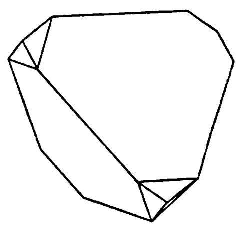


Fig. 175

Tetrahedrite

of which are shown in fig. 174, 175, are tetrahedral in habit. Massive forms are frequent. The color varies from a light steel-gray to an iron-black; the luster is metallic.

Tetrahedrite is commonly associated with chalcopyrite, massive varieties frequently forming intimate mechanical mixtures; crystals of tetrahedrite are often incrusted with chalcopyrite. It is also associated with several other metallic sulfids. It is found in Europe, South America, Mexico, Nevada and Colorado.

Stephanite (brittle silver ore) Ag_5SbS_4

Stephanite is a sulfantimonite of silver containing 16.3% sulfur, 15.2% antimony and 68.5% silver.

Orthorhombic crystals in short prismatic and tabular forms are frequently found. The mineral usually occurs in fine grained masses of an iron-black color and metallic luster. Also in disseminated grains.

Stephanite occurs in veins with other silver ores, the principal localities being those mentioned under argentite, pyrargyrite, etc.

Enargite Cu_3AsS_4

Enargite is a sulfarsenite of copper containing 32.6% sulfur, 19.1% arsenic and 48.3% copper.

Orthorhombic crystals are sometimes met with; these are prismatic in habit and striated parallel to the vertical axis. Enargite commonly occurs in columnar or granular masses. It is black in color and has a metallic luster.

Enargite is found associated with other copper minerals in Chile, Peru and Mexico; also in South Carolina, Colorado, Utah, California and in the Tintic district of Montana.

It is an ore of copper.

HALOIDS

CHLORIDS, BROMIDS, IODIDS, FLUORIDS

Halite (rock salt) NaCl

Halite or common salt is the chlorid of sodium and contains 39.4% chlorin and 60.6% sodium. It seldom occurs perfectly pure but is commonly mixed with calcium sulfate, calcium chlorid, magnesium chlorid and magnesium sulfate.

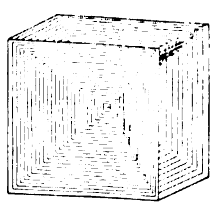


Fig. 176
Halite

Halite is isometric and usually crystallizes in cubes (pl. 17_2), which often show distortion and cavernous faces, as in fig. 176. Masses with perfect cubic cleavage are common as well as a fibrous variety which is said to be pseudomorphous after fibrous gypsum. Halite has a vitreous luster and when pure is colorless and transparent; yellow, red, brown, blue and purple shades are due to impurities, as is also the translucency accompanying these variations in color. It has a characteristic saline taste.

Salt is of wide distribution and frequently occurs in beds of sufficient size to constitute a true rock mass. These deposits, which are found interstratified with rocks of all geologic horizons, have been formed by gradual evaporation from bodies of water which have been cut off from the main body of the ocean, or which, as in the case of Great Salt lake and the Dead sea, have been concentrated through lack of an outlet. The mineral matter is crystallized out in inverse ratio to its solubility, the less soluble minerals, such as gypsum, forming prior to the more soluble ones such as salt. This process is still taking place in many parts of the world.

Halite is of of such universal occurrence that a list of its localities would include almost every civilized country. In the United States extensive and valuable deposits of salt are found in central and western New York, in Ohio, Michigan, West Virginia, Kansas, Louisiana, Nevada, Utah, Arizona and California. Salt springs and wells abound in the neighborhood of the salt deposits and these as well as the waters of salt lakes and sea waters are used as sources of the commercial product.

Halite is used to form a glaze on pottery and in many chemical and metallurgic industries as well as for the familiar culinary and preservative purposes.

Cerargyrite (horn silver) AgCl

Cerargyrite, the chlorid of silver, is composed of 24.7% chlorin and 75.3% silver.

Isometric crystals of a cubic habit are quite rare, the mineral usually occurring in massive crusts or coatings of a grayish green to violet color and waxy or resinous luster resembling horn or wax. It is extremely sectile and turns violet-brown on being exposed to the light.

Cerargyrite probably results from precipitation from silver charged solutions in contact with the chlorids contained in surface waters. It usually occurs near the top of veins in clay slate, associated with other ores of silver. Cerargyrite is found extensively in Peru, Chile and Mexico; it also forms part of the mineral wealth of Colorado, Nevada, Idaho and Utah.

It is mined for silver.

1 Fluorite, Cumberland, England

2 Fluorite, Macomb N. Y.

Fluorite (fluor spar) CaF_2

Fluorite is the fluorid of calcium and contains 48.9% fluorin and 51.1% calcium.

The isometric crystals of fluorite exhibit many interesting forms, some of which are shown in fig. 177–79. Penetration

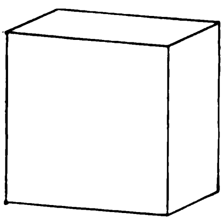


Fig. 177

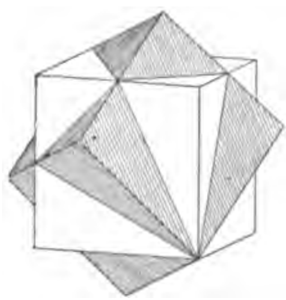


Fig. 178

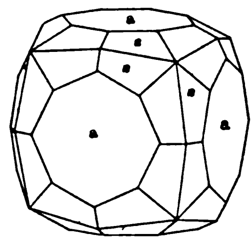


Fig. 179

Fluorite

twins are quite common (pl. 18_1). The crystals are vitreous, transparent and of a great variety of colors, white, yellow, greenish blue, purple and green being most common; white, pink, red, sky-blue and other colored varieties are often found. Massive varieties sometimes show irregular banding of different colors. Granular and fibrous occurrences are less frequent. All varieties are characterized by perfect cleavage parallel to the octahedron, which can be frequently traced in the crystallized specimens, as in pl. 18_2.

Fluorite is found in beds, or more often in veins, in gneiss, slate, limestone and sandstone; it frequently occurs as the gangue of metallic minerals, notably lead ores. Fluorite occurs in many parts of England and Saxony; also in Rosiclare Ill. where it is mined in large quantities, in Jefferson and St Lawrence counties, N. Y. and in several other states.

Fluorite is used as a flux in some metallurgic processes, also in the production of opalescent glass, enameled cooking ware and hydrofluoric acid.

Cryolite Na_3AlF_6

Cryolite is a fluorid of sodium and aluminium, containing 54.4% fluorin, 12.8% aluminium and 32.8% sodium.

The monoclinic crystals of cryolite frequently present a cubic aspect due to the fact that the β angle is nearly 90° and the

a and *b* axes almost equal. Parallel groupings are common as well as massive and columnar forms. The cleavage is nearly cubic in angle. Cryolite is transparent to translucent; colorless or white, often reddish, brownish or black owing to small amounts of iron, and has a vitreous to greasy luster. The German name *Eisstein* (ice-stone) suggests its resemblance to ice. It is quite soft (H=2.5) and is readily melted in the flame of a candle.

The principal locality for cryolite is Ivigtut in west Greenland, where it is found in a vein in gray gneiss.

It is used in several chemical processes, notably in the manufacture of aluminium.

Atacamite $Cu_2ClH_3O_3$

Atacamite is a hydrated oxychlorid of copper containing 16.6% chlorin, 14.9% copper, 55.8% copper oxid and 12.7% water.

Atacamite occurs in orthorhombic prismatic crystals, vertically striated. It is more commonly found in confused crystalline aggregates and fibrous or granular massive forms. The luster is adamantine to vitreous and the color bright to dark green.

Atacamite takes its name from the Atacama desert in northern Chile where it is found associated with other copper ores; it is also found in Bolivia, South Australia, Cornwall and Arizona.

It is an ore of copper.

OXIDS

OXID OF SILICON

Quartz SiO_2

Quartz is pure silica or silicon dioxid (53.3% oxygen and 46.7% silicon). It is often colored by small amounts of iron oxid, manganese, titanium, carbon, etc.

Quartz crystallizes in the rhombohedral-trapezohedral group of the hexagonal system; the crystals are commonly prismatic with the prism faces striated parallel to the basal plane and are terminated by one or both rhombohedrons together with other modifications characteristic of the group. Distortion gives rise to flat and unequally developed forms of great variety as well as acicular, tapering and twisted individuals. Grouping of crystals in parallel position, "scepter," "phantom," and capped

1 Quartz, Crystal mountain, Ark.

2 Quartz (smoky), St Gothard, Switzerland

forms are of particular interest from a crystallographic point of view. Twinning occurs quite frequently. Massive forms occur in great variety with granular mammillary stalactite and concretionary structure, plane or banded.

Quartz has a vitreous luster in the crystallized varieties which passes, in the massive forms, to greasy, splendent or dull.

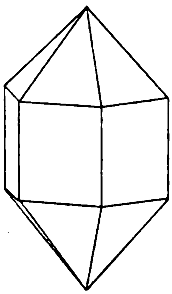


Fig. 180

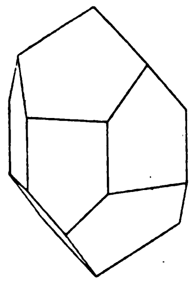


Fig. 181

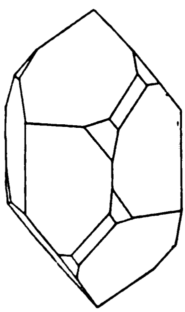


Fig. 182

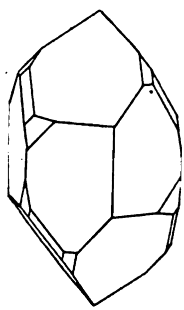


Fig. 183

Quartz

When pure, quartz is transparent and colorless with a white streak; various shades of yellow, red, brown, green, amethyst and black are due to slight impurities.

A—CRYSTALLINE VARIETIES

Rock crystal. Pure, colorless

Amethyst. Purple to violet. Color probably due to manganese

Rose quartz. Pink to rose. Colored by titanium

Smoky quartz. Smoky brown to black. Color probably due to carbon

Milky quartz. Translucent white. Usually massive

Ferruginous quartz. Opaque brown to red. Colored by iron

Aventurin. Spangled with scales of mica, hematite etc.

B—CRYPTOCRYSTALLINE VARIETIES

Chalcedony. Mammillary. Uniform in tint
Carnelian. A clear, red chalcedony
Chrysoprase. Apple green. Color due to nickel
Prase. Dull, leek-green
Agate. A variegated chalcedony. Colors are banded, irregularly clouded or in mosslike dendritic forms
Onyx. Parallel layers light and dark
Jasper. Impure, opaque.

Quartz occurs as a constituent of many rocks such as granite, gneiss, quartz porphyry, syenite, sandstone, etc. and as a vein mineral in rocks of all geologic horizons. Its distribution is so extensive as to preclude its limitation to any given area. Quartz rocks are extensively used for building stone; chalcedonic varieties are often polished for ornamental objects and massive varieties are ground and used in the manufacture of sandpaper, glass and porcelain and as an acid flux in some metallurgic processes.

Opal $SiO_2.nH_2O$

Like quartz, opal is composed of silica or silicon dioxid, but contains from 5% to 12% water.

Opal shows no evidences of crystallization and is therefore considered amorphous. It occurs in transparent to translucent milky white or red masses and veins, often characterized by internal reflections and rich play of colors; in waxy masses yellow, red, brown, green, gray or blue in color; in opaque, porous, brittle stalactitic masses deposited by geysers and hot springs and in earthy varieties.

VARIETIES

Precious opal. Exhibits play of color. Used as a gem
Fire opal. Red, firelike reflections
Common or semiopal. In part translucent with greasy luster
Wood opal. Pseudomorphous after wood
Hyalite. Colorless, transparent, droplike masses
Geyserite. Porous opal, deposited from hot water carrying silica
Tripolite. Massive, chalklike silica composed of the remains of diotomes.

1 Quartz (agate), Wyoming

2 Cuprite (chalcotrichite), Morenci Ariz.

Opal occurs in cavities and fissures in igneous rocks, as concretions in limestones, as sinter in the vicinity of geysers, hot springs, etc. The precious variety is found in Hungary, Australia, Mexico and in Washington and Idaho.

Precious opal is highly valued as a gem. The chalky variety is used for polishing and washing purposes, in the manufacture of dynamite and in the preparation of a soluble glass.

OXIDS OF METALS

Cuprite (red copper ore) Cu_2O

Cuprite is the oxid of copper and contains 11.2% oxygen and 88.8% copper.

Crystals of cuprite (fig. 184, 185) are isometric, the prevailing

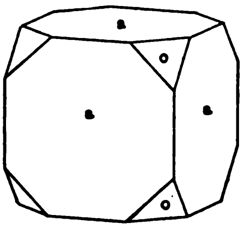


Fig. 184

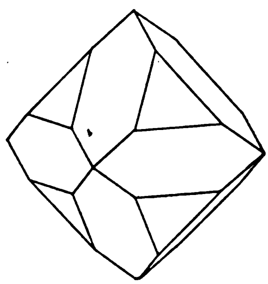


Fig. 185

Cuprite

forms being the cube, octahedron and dodecahedron, often highly modified; in the variety chalcotrichite the cube crystals are distorted to such an extent as to produce hairlike forms (pl. 20_2). Massive, granular and earthy forms are common. The luster of cuprite is submetallic or adamantine to earthy and the color varies from a dark red which is nearly black to a vermilion or scarlet, seen in some of the massive varieties. It is transparent to opaque.

Cuprite results from the oxidation of the sulfids of copper and is found associated with other copper minerals and with limonite. It occurs in fine crystals in the Cornwall mines and is found in considerable deposits in Chile, Bolivia, Peru, the Lake Superior region and Arizona.

It is a useful copper ore.

Zincite (red zinc ore) ZnO

This oxid of zinc contains 19.7% oxygen and 80.3% zinc; it usually carries some manganese.

The natural crystals, which are rare, have been referred to the hemimorphic group of the hexagonal system. Zincite ordinarily occurs in deep red to brick-red adamantine masses with a foliated or granular structure or as coarse grains disseminated through the matrix. It has a subadamantine luster and is translucent.

Zincite occurs in the vicinity of Franklin N. J. associated with the minerals characteristic of that locality and is mined with the associate minerals for the zinc which it contains.

Corundum (emery) Al_2O_3

Corundum is alumina, or sesquioxid of aluminium, and contains 47.1% oxygen and 52.9% aluminium; massive emery contains more or less iron oxid as an impurity.

Crystals of corundum are rhombohedral (fig. 186, 187); rough

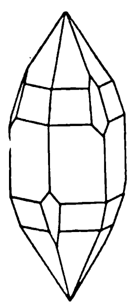


Fig. 186

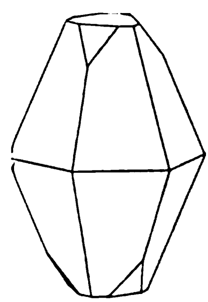


Fig. 187

Corundum

and rounded forms are characteristic, as well as twinning, which is indicated by laminated structure and intersecting striations. With the exception of the diamond, corundum is the hardest substance known.

The precious varieties known as sapphire and ruby are transparent or translucent, with vitreous to adamantine luster, and abound in fine colors.

The gems cut from these varieties are:

Sapphire. Blue in color

Oriental ruby. A rich red

1 Hematite (Eisenrosen), St Gothard, Switzerland

2 Magnetite (lodestone), Magnet Cove Ark.

Oriental topaz. Yellow
Oriental emerald. Green
Oriental amethyst. Purple

An opaque variety of corundum occurs in coarse nodular crystals with a marked rhombohedral parting and of a dull blue, gray, brown or black color.

The variety known as emery is granular in texture, of great toughness and black or grayish black in color. It is commonly intermingled with hematite or magnetite. This variety, which is of great value as an abrasive, is found in a number of grades, classed on the relative coarseness of the corundum crystals or grains.

The gem varieties of corundum are found in the gravel of river beds in Upper Burma and Ceylon; some handsome gems have been obtained from Montana and North Carolina.

Corundum occurs in many crystalline rocks associated with minerals of the chlorite group, tourmalin, spinel, cyanite, etc. and has been observed in some of the younger volcanic rocks. It is mined for emery in the island of Naxos, in Asia Minor, and in the United States at Chester Mass., in Westchester county, N. Y. and elsewhere.

Hematite (specular iron) Fe_2O_3

Hematite is the sesquioxid of iron and contains 30% oxygen and 70% iron.

Hematite crystallizes in the rhombohedral group of the hexagonal system. The crystals are commonly thick or tabular in habit (fig. 188) as distinct from the tapering forms of corundum, and are often reduced to thin plates which in some varieties group themselves in rosettes (eisenrosen pl. 21_1). Massive forms in compact columnar, radiated and kidney-shaped masses pass into loose earthy varieties, containing more or less clay. The luster of hematite varies with its form from a splendent metallic, in the crystallized varieties, to dull in the ocherous and argillaceous hematite; the color also varies from iron-black to red. The streak is red in all varieties.

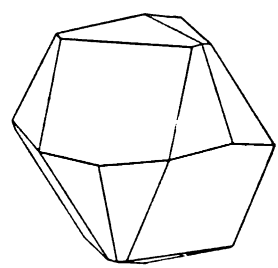


Fig. 188
Hematite

Hematite occurs in rocks of all geologic horizons. It is widely distributed and the numerous foreign localities afford beautifully crystallized specimens. In the United States vast beds of hematite are found in the Archaean rocks of northern Michigan, northern Wisconsin, Minnesota, Missouri, and in Jefferson and St Lawrence counties of northern New York; also in the Clinton group of the Upper Silurian in New York and Pennsylvania.[1]

Hematite constitutes the chief source of iron; the earthy variety is ground for paint.

Ilmenite or menaccanite (titanic iron ore) $(Fe,Ti)_2O_3$

Ilmenite is an oxid of iron and titanium containing 31.6% oxygen, 31.6% titanium and 36.8% iron. The crystals, which are trirhombohedral, somewhat resembles those of hematite in habit (fig. 189). Ilmenite commonly occurs in iron-black plates and masses of submetallic luster, also in embedded grains or as loose sand.

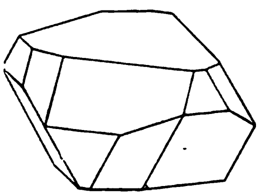


Fig. 189
Ilmenite

Ilmenite is found in many igneous rocks notably in gabbros and diorites; it is sometimes altered to limonite and titanite. In addition to several European localities ilmenite is found in the town of Warwick, Orange co. N. Y. and at Litchfield Ct.

The large amount of fuel required to reduce this mineral renders it, in most cases, undesirable as an ore of iron. It is, however, used as a lining in furnaces.

Spinel $MgO.Al_2O_3$

Spinel, the magnesium aluminate, contains 71.8% alumina and 28.2% magnesia. These two components may be replaced in part by ferrous and ferric iron, manganese and chromium.

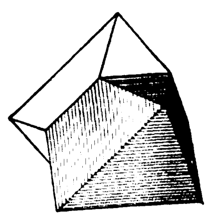


Fig. 190
Spinel

The crystals of spinel are isometric, usually the octahedron or the octahedron modified, and are frequently twinned (fig. 190). The luster is vitreous to dull and the color varies from red to blue, green, yellow and black. A transparent variety called ruby spinel is transparent to translucent and often of a rich red color. This constitutes the gem known as

[1] N. Y. state mus. Bul. 7. 1889.

spinel ruby or balas ruby, which often rivals the oriental ruby in color and fire.

Spinel occurs in limestone, gneiss, serpentine and other metamorphic rocks. Spinel ruby is abundant in Ceylon and Burma and has been obtained from Hamburg N. J. and Orange county, N. Y. Crystals of spinel are found in many parts of North Carolina and Massachusetts and near the boundary line between New York and New Jersey.

Magnetite (magnetic iron ore) $FeO.Fe_2O_3$

Magnetite is composed of iron sesquioxid and iron protoxid and contains 72.4% iron and 27.6% oxygen.

Magnetite crystallizes in isometric forms closely resembling those of spinel. Parting parallel to the octahedron is often developed (*see* specimen from Mineville N. Y. in N. Y. state mus. collection). Massive varieties have laminated, coarse or fine granular and compact structure (pl. 4_2). Magnetite has a metallic or submetallic luster, is black in color and is strongly magnetic. A variety known as lodestone is a natural magnet (pl. 21_2).

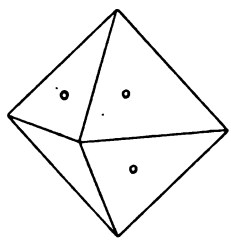


Fig. 191
Magnetite

Magnetite occurs mostly in crystalline rocks and is of universal distribution. Extensive beds are found in the Archaean formation of northern New York and in the Adirondack region, as well as in Saratoga, Herkimer, Orange and Putnam counties of the same state,[1] the former deposits being to a considerable extent titaniferous.

Magnetite is extensively mined for iron.

Franklinite $(FeMnZn)O.(FeMn)_2O_3$

Franklinite is an iron, zinc and manganese ferrate and manganate of rather complicated formula and varying relative quantities.

The isometric crystals of franklinite are octahedral in habit and are generally characterized by rounded edges, otherwise they resemble those of magnetite. Franklinite also occurs in rounded grains and in compact masses. In color and luster it

[1] N. Y. state mus. Bul. 7. 1889.

closely resembles magnetite and is chiefly distinguished by its slight tendency to attract the magnet and by its characteristic association with zincite and willemite at Franklin and Ogdensburg N. J. its most notable localities.

It is used at Franklin with other ores for the production of zinc and of an alloy of iron and manganese known as spiegeleisen.

Chromite (chromic iron) $FeO.Cr_2O_3$

Chromite, the iron chromate, contains 68% chromium sesquioxid and 32% iron protoxid.

Chromite is rarely found in small octahedral crystals. It commonly occurs as a black massive mineral resembling massive magnetite, sometimes in disseminated grains and sand. It is, in some instances, feebly magnetic.

It occurs in veins or embedded masses in serpentine and may often be recognized by its association with that mineral.

Turkey and New Caledonia furnish much of the chromite now used. A somewhat lower grade ore is found in extensive deposits in California.

Chromium extracted from chromite is used in the production of several pigments, in the manufacture of bichromate of potash for calico printing and for chrome steel.

Chrysoberyl $BeO.Al_2O_3$

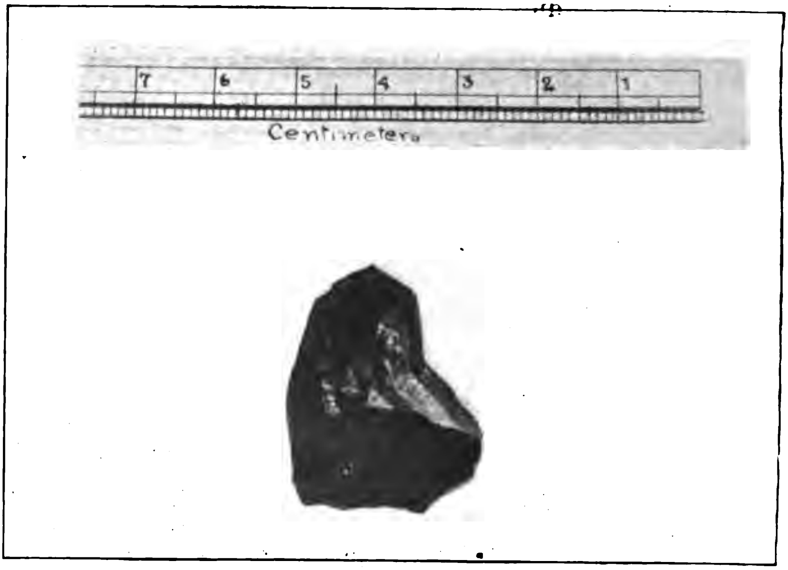
Chrysoberyl is the aluminate of beryllium and contains 80.2% alumina and 19.8% glucina.

The crystals of chrysoberyl, which are orthorhombic, are commonly twinned producing pseudohexagonal shapes which sometimes show reentrant angles. The crystals are generally tabular in habit with intersecting, featherlike striation due to repeated twinning. Chrysoberyl is transparent to translucent, of a vitreous luster and of various colors from a pale yellowish green to emerald-green. The variety alexandrite is of an emerald-green color by reflected light which, however, changes to a columbine-red by transmitted light.

Brazil, Ceylon, Moravia and the Ural mountains of Russia produce chrysoberyl. It has been found at Haddam Ct. and at Greenfield N. Y.

Chrysoberyl is used as a gem, the varieties alexandrite and cat's eye being specially prized.

To face p. 75



1 Cassiterite, Schlaggenwald, Bohemia

2 Rutile, Magnet Cove Ark.

Cassiterite (stream tin) SnO_2

ite is the dioxid of tin containing 21.4% oxygen and

nal crystals of the general type shown in fig. 192 are
l with a low pyramid. Forms of prismatic habit
per and more complicated term-
re also characteristic, and twins
the form shown in pl. 22_1 are
non. Reniform masses and rounded
with fibrous radiated structure
n) are of common occurrence. The
assiterite is adamantine and in the
stallized varieties is usually splend-
olor is brown or black, sometimes
or yellow, and the streak is brown.

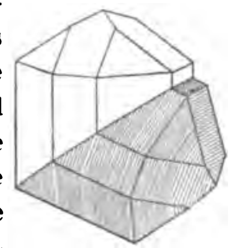


Fig. 192
Cassiterite

ite occurs in veins traversing granite, gneiss and other
d metamorphic rocks. It is found abundantly in Corn-
other parts of England, in Bohemia, Saxony, East
stralia, Bolivia and Mexico; also in the United States
akota, California and other states.
ite is the sole source of tin.

Rutile (nigrin) TiO_2

the dioxid of titanium and contains 40% oxygen and
m.

llization rutile closely resembles cassiterite (fig. 193).
ls are prismatic in habit, often passing into acicular

and hairlike forms which are vertically striated
and are sometimes included in quartz and other
minerals. Twinning, resulting in knee-jointed
crystals and rosettes (pl. 22_2), is quite common.
Rutile is occasionally found in compact masses
which carry some iron. The luster of rutile is
rather more brilliant and metallic than cassiter-
ite and may be described as metallic-adamantine;
varies from brownish red to nearly black and when
nsmitted light in transparent varieties it is deep red.
curs in granite, gneiss, syenite, mica, slate and some-
ne limestones; it is frequently embedded in other

minerals and is of common occurrence as grains or fragments in many gold-bearing sands. It is found in many parts of Europe and also in Maine and Georgia, at Magnet Cove Ark. and in Orange county, N. Y.

Rutile is chiefly used to color porcelain and may serve as a source of titanium.

Octahedrite. Octahedrite is a tetragonal mineral of the same composition as rutile but differs slightly from it in crystallization.

Brookite. Brookite is an orthorhombic form of titanium dioxid closely related to the two foregoing minerals.

Pyrolusite MnO_2

Pyrolusite is the dioxid of manganese and contains 36.8% oxygen and 63.2% manganese.

Pyrolusite commonly occurs in columnar masses which frequently radiate from a center; also in fine grained massive stalactitic and dendritic forms (pl. 8_2), in layers interposed with psilomelane and in velvety, reniform crusts. It is black in color and so soft (H–1–2.5) that it leaves a black mark on paper. The luster is metallic or dull.

Pyrolusite occurs associated with psilomelane, hematite, limonite and manganite. It is found in central Europe, India, Australia and Cuba; deposits occur in the United States in Virginia, Georgia, Arkansas, California, Vermont and North Carolina; New Brunswick and Nova Scotia furnish a high grade material.

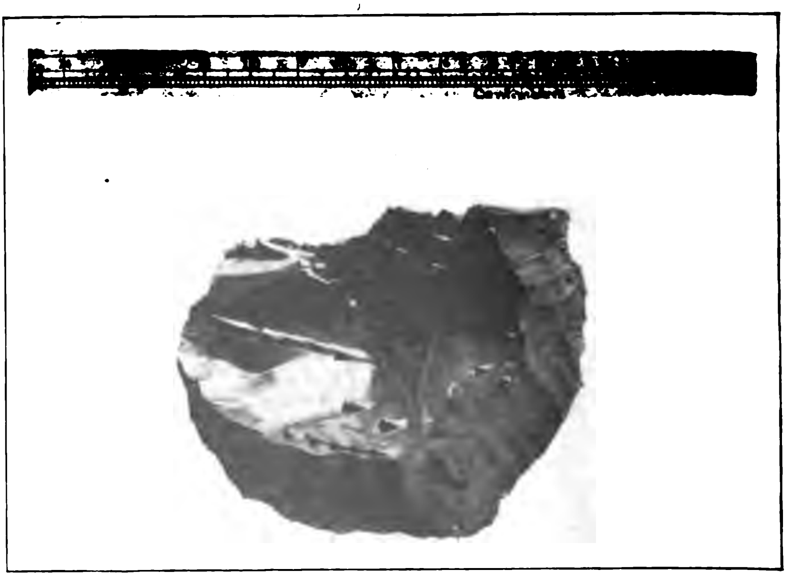
Pyrolusite is used in the manufacture of various useful alloys, as an oxidizing agent in the manufacture of chlorin, bromin and disinfectants and in calico printing, glass coloring, etc.

Göthite $Fe_2O_3.H_2O$

Göthite is a hydrated sesquioxid of iron and contains 27% oxygen, 62.9% iron and 10.1% water.

The orthorhombic crystals of göthite are prismatic in habit, striated in the direction of the vertical axis and often flattened in the direction of the brachyaxis into scales. Needlelike crystals grouped in radiating or parallel position pass into massive featherlike structure and reniform and stalactitic forms.

1 Manganite, Ilefeld, Hartz, Germany



2 Limonite, Richmond Mass.

The luster is adamantine and the color yellowish, reddish and blackish brown.

Göthite occurs with other oxids of iron specially hematite and limonite and is classed commercially with limonite under the name of "brown hematite." It is an ore of iron.

Manganite $Mn_2O_3.H_2O$

Manganite is a hydrated sesquioxid of manganese containing 27.3% oxygen, 62.4% manganese and 10.3% water.

Manganite occurs in orthorhombic crystals usually prismatic with deeply striated or grooved surfaces; these are frequently grouped in bundles giving the appearance of sheaves of rods (pl. 23_1). It is rarely found in massive granular or stalactitic forms. The luster of manganite is submetallic and the color gray to black.

Manganite occurs associated with other manganese minerals which commonly result from its alteration.

For uses see Pyrolusite.

Limonite (brown hematite) $2Fe_2O_3.3H_2O$

Limonite is a hydrated sesquioxid of iron differing from göthite in the relative amount of iron sesquioxid and water; it contains 25.7% oxygen, 59.8% iron and 14.5% water. The ocherous varieties often contain clay or sand.

Limonite does not occur crystallized. It is commonly found in mammillary, botryoidal or stalactitic masses grading into loose and porous bog ore and earthy and concretionary masses.

The compact variety has a black varnishlike surface and fibrous radiated structure (pl. 23_2). The forms of looser structure are characterized by a dull luster and range in color from brown to yellow. The streak of limonite is brown.

Limonite is formed from the decomposition or alteration of other minerals containing iron; thus the bog ore is deposited in a marshy place by streams carrying iron in solution which is oxidized, sinks to the bottom, and in time by the combined action of heat and pressure is transformed into a bed of limonite.

Limonite is found in Bavaria and other parts of Germany, in Scotland, Sweden, etc. It is mined from large deposits in Virginia, Alabama, Pennsylvania, Michigan, Tennessee and

Georgia and in Dutchess and Columb... also found in Richmond co. N. Y.

Limonite is an abundant but low grade ore of iron; the ocherous varieties are ground for paint.

Bauxite $Al_2O_3.2H_2O$

Bauxite is a hydrous aluminium sesquioxid containing 73.9% alumina and 26.1% water. The aluminium is often replaced in part by iron. Bauxite occurs in disseminated, rounded grains and in oolitic, spongy or claylike masses; sometimes fine grained compact. The luster is dull and the color varies from white when pure to red, yellow, and brown for the iron-bearing varieties.

Bauxite is found at Baux and elsewhere in France; also in Arkansas, Alabama and Georgia. It is the chief source of aluminium and is used in the manufacture of alum.

Brucite $MgO.H_2O$

Brucite is the magnesium hydrate and contains 69% magnesia and 31% water.

The crystals are rhombohedral and tabular in habit. The mineral is of more frequent occurrence in translucent foliated masses and in fibrous forms. The luster is pearly or waxy to vitreous and the color white, gray, bluish or green.

Brucite occurs in serpentine and limestone associated with other magnesium minerals. It is found at Hoboken N. J., at Brewster, Putnam co. and in Richmond and Westchester counties N. Y.; also at Texas Pa.

Gibbsite $Al_2O_3.\ 3H_2O$

Gibbsite is an aluminium hydrate containing 65.4% alumina and 34.6% water.

It is rarely found in six sided monoclinic crystals, but usually occurs in mammillary crusts and stalactitic shapes (pl. 24[1]) which sometimes show an ill defined, fibrous, internal structure. The color is commonly white or nearly white but may be grayish, greenish, reddish or yellow; the luster is subvitreous. The mineral is found in small deposits, often associated with limon-

[1] N. Y. state mus. Bul. 7. 1889.

Plate 24

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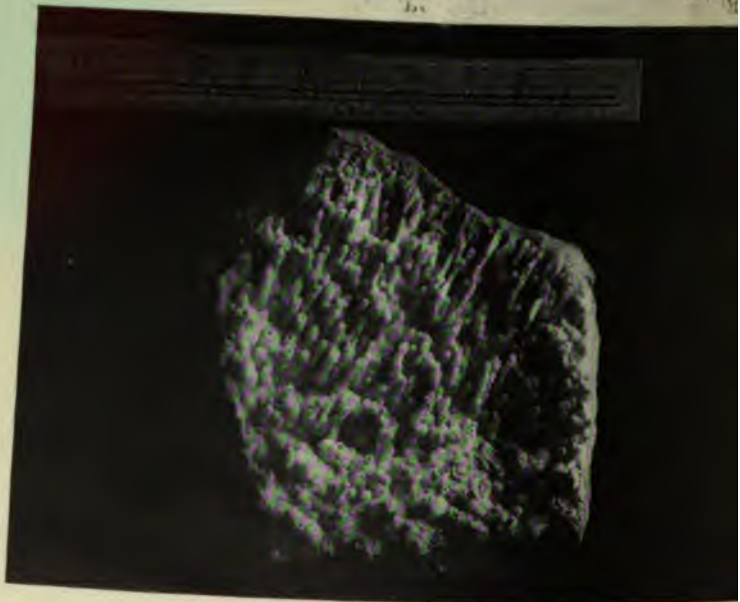
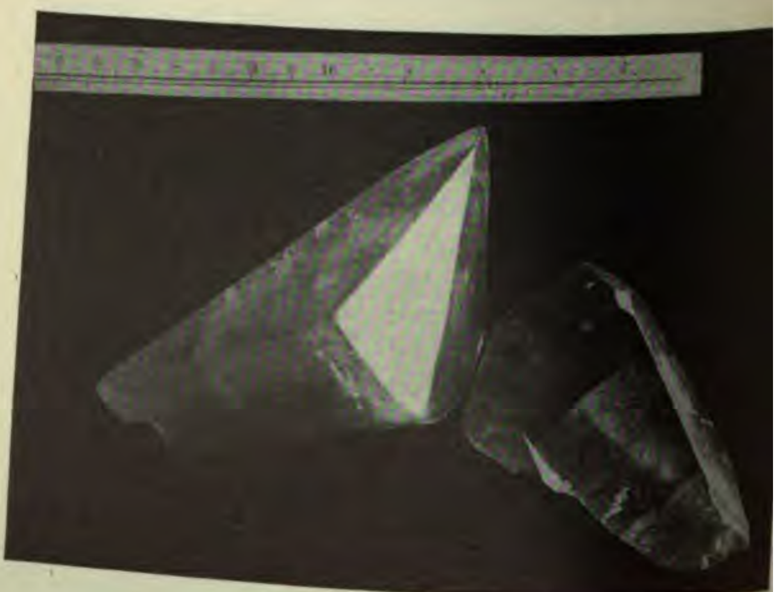


1 Gibbsite, Richmond Mass.



2 Calcite, Joplin Mo.

A steep rhombohedron also occurs modified in many ways, also crystals of prismatic habit (pl. 25_1). **Twins are of common occurrence and are of several forms one of which is shown in fig. 199.** Calcite also occurs massive with easy rhombo-

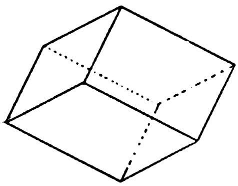


Fig. 194

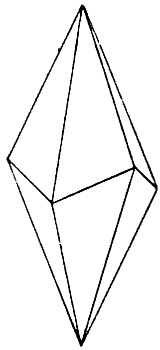


Fig. 195

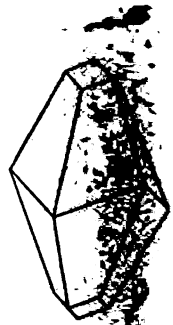


Fig. 196

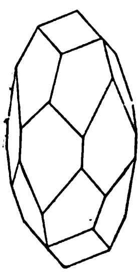


Fig. 197

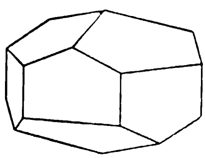


Fig. 198

Calcite

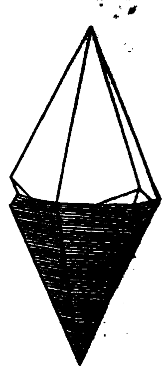


Fig. 199

hedral cleavage, fibrous (satin spar), coarse and fine granular (crystalline limestone and marble), pulverulent (chalk), stalactitic, etc.

The luster of calcite ranges from vitreous in the crystallized varieties to dull in the limestones and chalk. It is normally colorless or white but often red, green, blue, violet, yellow, brown or black from impurities.

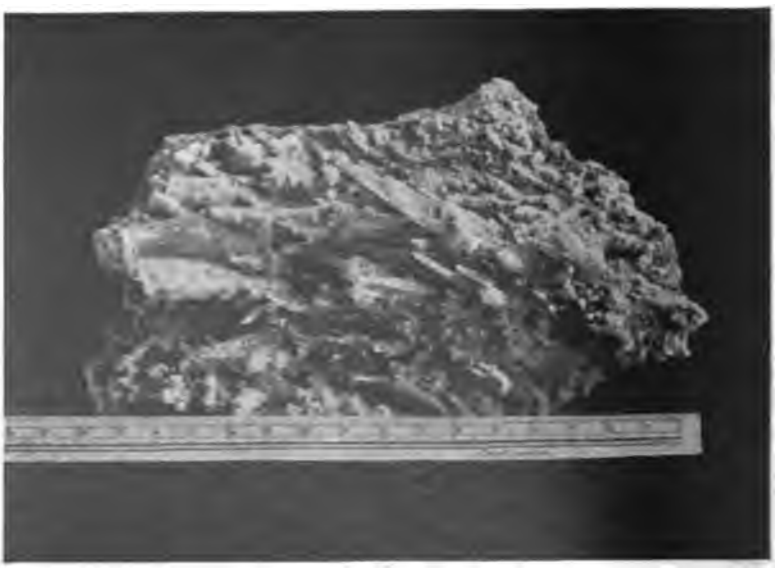
Calcite is readily distinguished by its characteristic rhombic cleavage in three directions as well as by the fact that it is easily scratched by a knife (H. 3) and that a drop of dilute hydrochloric acid will cause it to effervesce violently.

1 Calcite, Egremont, England

2 Calcite, Rossie N. Y.

To face p. 81

1 Dolomite, Lockport N. Y.



2 Aragonite, Banat, Hungary

Calcite is probably the most widely distributed mineral. Great beds of limestone are found among the rocks of nearly every geologic horizon. Calcite also occurs as a vein mineral, in the form of stalactites and stalagmites in caves, and as a frequently associated mineral with metallic ores.

As limestone and marble, calcite is quarried to a considerable extent in Vermont, Georgia, Tennessee, Alabama, California, New York,[1] Pennsylvania and Massachusetts. Calcite in the form of limestone and marble is extensively used as a building stone; it is also burnt for quick lime, Portland and other cements and is of value as a flux for certain silicious ores. Certain varieties are used for lithographic stone, and the colorless, transparent variety is employed in optical apparatus for polarizing light.

Dolomite (pearl spar) $(CaMg)CO_3$

Dolomite is the carbonate of calcium and magnesium containing 47.9% carbon dioxid, 30.4% lime and 21.7% magnesia.

In crystallization dolomite closely resembles the rhombohedral forms of calcite. It may, however, be readily distinguished from the latter by the marked curvature of the rhombohedral faces (pl. 26_1). Massive coarse or fine granular varieties are distinguished with difficulty from the corresponding forms of calcite.

The luster of dolomite is vitreous to pearly; the color is commonly white, pink or gray and less frequently rose-red, green, brown or black.

Dolomite in the form of dolomitic limestone constitutes extensive strata in many geologic formations and forms a series from pure limestone to pure dolomite. Compact and crystalline varieties frequently occur with serpentine and other magnesium minerals.

In New York dolomite is found at Lockport and Niagara Falls, Niagara co.; at Brewster, Putnam co.; Union Springs, Cayuga co., and in many other localities.[1]

It is used for much the same purposes as calcite.

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[1] N. Y. state mus. Bul. 15. 1896.

Magnesite $MgCO_3$

Magnesite, the carbonate of magnesium, contains 52.4% carbon dioxid and 47.6% magnesia.

Rhombohedral crystals of magnesite are rare. It occurs commonly in granular, cleavable or compact earthy masses and as veins in serpentine. The luster is dull, sometimes vitreous or silky, and the color white, yellowish or grayish white and sometimes brown.

Magnesite is commonly associated with serpentine, talc, brucite and other magnesium minerals. Much of the marble known as verd antique is composed of serpentine veined with magnesite. It is found in Quebec, Pennsylvania, Maryland and in several places in California and Massachusetts. It has been found in the serpentine rocks of Westchester county, N. Y.

Magnesite is used as a refractory material for the lining of converters, etc.; also in the manufacture of epsom salts and carbon dioxid for soda water.

Siderite (spathic iron ore) $FeCO_3$

Siderite is the iron protocarbonate and contains 37.9% carbon dioxid and 62.1% iron protoxid (a composition equivalent to 48.2% iron). Manganese, magnesium or calcium may also be present in small quantities.

Siderite is rhombohedral in crystallization, the crystals being commonly rhombohedral in habit with curved faces resembling those of dolomite. It is characterized in massive varieties by the oblique rhombohedral cleavage common to this group of carbonates. In color siderite is mostly grayish yellow or brown, ranging from pale buff shades to dark brown or black. The luster is vitreous to pearly and the mineral in general resembles dolomite but is somewhat heavier and in most instances is distinguished by its brown color.

Massive siderite is often formed by the action of decaying vegetable matter on limonite. It occurs in gneiss, mica and clay slate and as clay iron stone in coal formations. It is found abundantly in Cornwall and other English localities; also in the coal formations of Pennsylvania, Ohio, Virginia and Tennessee, at Hudson and Burden, Columbia co. and at Antwerp, Jefferson co. N.Y.[1] Siderite supplies a little over 1% of American iron ore.

[1] N. Y. state mus. Bul. 7. 1889.

Rhodochrosite $MnCO_3$

Rhodochrosite is a manganese carbonate containing 38.3% carbon dioxid and 61.7% manganese protoxid.

It occurs occasionally in rhombohedral crystals similar in shape to those of dolomite but more frequently in vitreous or pearly masses of pink to brown color with a marked rhombohedral cleavage; less frequently in globular and botryoidal forms with columnar structure or incrusting; granular or compact masses are common.

Rhodochrosite is often found associated with gold and silver ores notably at Butte Mont., in Nevada, Colorado and elsewhere. As yet it has no commercial value.

Smithsonite (dry bone ore) $ZnCO_3$

Smithsonite is a carbonate of zinc containing 35.2% carbon dioxid and 64.8% zinc protoxid. Small amounts of copper, cadmium, etc. frequently produce marked differences in the color.

Distinct crystals of smithsonite of rhombohedral form are of quite rare occurrence. It is commonly found in reniform, botryoidal or stalactitic masses, often with a drusy surface. It occurs also in spongy, granular and earthy forms. The luster is vitreous to dull and the color normally white or light in shade but often highly colored by impurities. The common variety of smithsonite resembles calcined bones, as indicated by the name given to it by miners.

Smithsonite is essentially a secondary product formed from other zinc ores by the action of carbonated waters. It is found in veins and beds associated with other ores of zinc as well as those of lead, copper and iron. It is found abundantly in this country in the zinc regions of Missouri, Virginia and Wisconsin.

As an ore of zinc smithsonite is highly valued on account of the ease with which it is reduced. The deposits are now nearly exhausted.

Aragonite $CaCO_3$

Aragonite, which is a calcium carbonate, has the same composition as calcite but differs from the latter in crystallization.

The crystals of aragonite are orthorhombic, sometimes pris-

matic in habit (fig. 200) with acute terminations (domes and pyramids) which merge into radiating needlelike forms (pl. 26_2). A twinning, which is characteristic of this group of carbonates, produces prismatic forms which somewhat resemble hexagonal prisms (fig. 201, pl. 27_1). Stalactitic incrusting, columnar and corallike forms (pl. 8_1) also occur. The prevailing color is white,

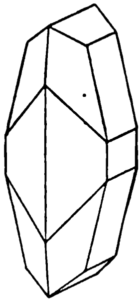


Fig. 200

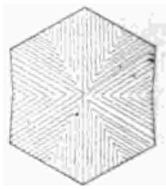


Fig. 201

Aragonite

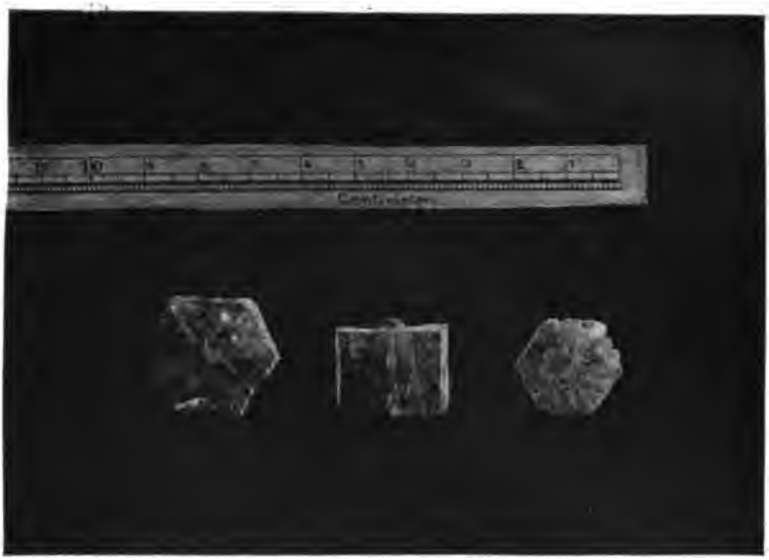
which shades to violet, yellow and pale green in some varieties; the luster is vitreous.

Crystallized varieties may be distinguished from calcite by the difference in form but massive specimens can only be determined by cleavage and optical tests. Aragonite is formed in much the same way as calcite, but is of far less common occurrence. It is often found associated with gypsum and serpentine and with iron ore as flos ferri (pl. 8_1). In the United States aragonite is found in several localities in California, in Connecticut, Illinois, Missouri, New Mexico and Pennsylvania and in Niagara, Orange and Madison counties, N. Y.

Witherite $BaCO_3$

Witherite is a barium carbonate containing 22.3% carbon dioxid and 77.7% baryta.

Though witherite is orthorhombric in crystallization single crystals are practically unknown; twinned forms resembling a series of hexagonal pyramids superposed are characteristic (pl. 27_2). It also occurs massive in columnar or granular structure. The luster is vitreous and the color white, gray or yellowish.



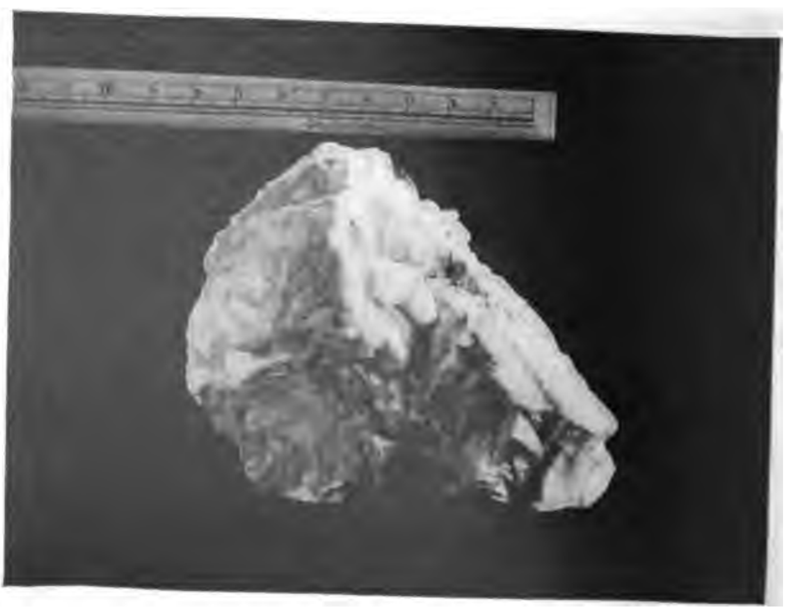
1 Aragonite, Bastenes, France

2 Witherite, Fallowfield, England

Plate 28

To face p. 83

1 Cerussite, Arizona



2 Albite, Branchville Ct.

Witherite is mined at Fallowfield Eng. Small deposits of the mineral occur near Lexington Ky. and at Thunder bay, Lake Superior.

It is used as an adulterant of white lead and in the refining of beet sugar molasses.

Strontianite $SrCO_3$

Strontianite, the carbonate of strontium, contains 29.9% carbon dioxid and 70.1% strontia.

Distinct orthorhombic crystals are quite rare. Radiated, spear-shaped or acicular crystalline aggregates are common; also columnar, fibrous and granular masses. The luster of strontianite is vitreous and the color is white, pinkish or greenish.

Strontianite is found in New York at or near Schoharie, Schoharie co., Clinton, Oneida co. and in several localities in Jefferson county.

It is an important source of strontium compounds used in the manufacture of fireworks.

Cerussite (white lead ore) $PbCO_3$

Cerussite, the carbonate of lead, contains 16.5% carbon dioxid and 83.5% lead oxid. It sometimes carries a little silver.

The crystals of cerussite are orthorhombic, often of tabular

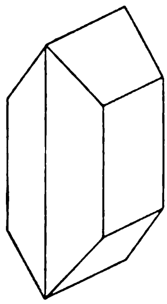


Fig. 202

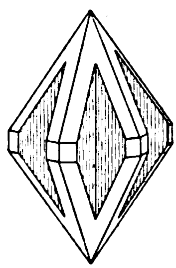


Fig. 203

Cerussite

habit, flattened parallel to the *a* and *c* axes as in fig. 202; the repeated twinning of this type yields six rayed forms as shown in fig. 203. Crystals of prismatic and pyramidal habit are also frequent. Clusters of interlaced fibrous crystals pass into silky aggregates and masses (pl. 28_1). Granular, compact or earthy

masses are common. Distinct individual crystals are commonly transparent with an adamantine luster and are colorless or white. Massive varieties are translucent to opaque and have a silky luster which in the earthy forms is nearly dull. The color is white, gray or grayish black.

Cerussite occurs with other lead minerals and results from the alteration of galena by the action of water charged with carbon dioxid. It is found in many parts of England and in central Europe; also in Pennsylvania, Virginia, North Carolina and in Wisconsin and other lead regions of the northwestern states and in Colorado and Arizona.

It is mined for lead and silver and is used in a direct process for the production of white lead.

Malachite (green carbonate of copper) $CuCO_3 . Cu(OH)_2$

Malachite is a basic carbonate of copper and contains 19.9% carbon dioxid, 71.9% copper oxid and 8.2% water.

Distinct monoclinic crystals are rare. The mineral commonly occurs in bright green masses and crusts of botryoidal surface and radiating, silky fibrous structure, showing a banding of light and dark green. It is also found in stalactitic forms and earthy masses. The luster is adamantine, silky to dull, and the color bright to dark green.

Malachite is formed by the action of water charged with carbon dioxid on other copper minerals. Large deposits are found at Bisbee Ariz. and adjacent regions. It is also found to a considerable extent in Siberia, Chile and Australia and is of frequent occurrence in all deposits of copper ore.

It is a source of copper and is frequently polished for ornamental objects.

Azurite (blue copper ore) $2CuCO_3 . Cu(OH)_2$

Azurite is a basic copper carbonate differing slightly from malachite in composition. It contains 25.6% carbon dioxid, 69.2% copper oxid and 5.2% water.

Azurite occurs in monoclinic crystals of varied habit and often highly modified. Massive forms sometimes show columnar structure. As an incrustation it often has a velvety luster. It has a vitreous luster and is distinguished by its characteristic blue color.

It is formed in the same way as malachite and occurs associated with it at the localities named under the latter mineral.

Azurite is an ore of copper.

SILICATES

The members of this division are mainly important as rock-forming minerals. They are oxygen salts in which silicon is present as the acid element and are classed according as they are salts of disilicic acid ($H_2Si_2O_5$), polysilicic acid ($H_4Si_3O_8$), metasilicic acid (H_2SiO_3) or orthosilicic acid (H_4SiO_4) into disilicates, polysilicates, metasilicates, orthosilicates.

Subsilicates represent a group of basic silicates having a lower oxygen ratio than the foregoing.

Disilicates, polysilicates

Feldspar group

For many reasons the feldspars are considered the most important group of minerals in the large division of the silicates. They form an essential constituent in a number of rocks such as granite, syenite, gneiss, etc. which are of primary importance as building materials and are largely quarried in all parts of the world. As a group of minerals the feldspars present several general characteristics which unite them in close relation to each other.

1 Crystallizing in the monoclinic and triclinic systems, the feldspars agree closely in crystal habit, prism angle and methods of twinning.

2 They are characterized by two easy cleavages inclined to one another at an angle which is close to 90°, the cleavage surfaces being smooth and of high polish.

3 In hardness they vary between the comparatively close limits of 6 and 6.5.

4 They range in color from clear and colorless through white, pale shades of yellow, pink or green, to less common dark gray tints.

5 The feldspars are silicates of aluminium and some other base, commonly potassium, sodium or calcium, less frequently barium.

Orthoclase (potash feldspar) $KAlSi_3O_8$

Orthoclase is a silicate of aluminium and potassium. Part of the potassium is often replaced by sodium giving rise to a variety known as soda-orthoclase.

The crystals of orthoclase are monoclinic, a type of frequent occurrence being that shown in fig. 204. Types of prismatic

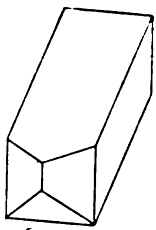


Fig. 204

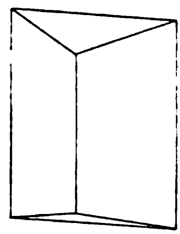


Fig. 205

Orthoclase

habit, often orthorhombic in aspect from the equal development of the basal pinacoid and positive hemiorthodome (fig. 205), are often found in the transparent variety called adularia.

Twin crystals occur quite frequently and are ordinarily of three types, the Carlsbad, the Baveno and the Manebach type.[1] The cleavage of orthoclase takes place in two directions parallel to the basal and clinopinacoid and at an angle which is close to 90°. Cleavable masses are quite common. Also compact non-cleavable masses resembling flint.

The luster of orthoclase is vitreous or pearly and the color is commonly flesh-red, yellowish, white or colorless; more rarely gray or green.

Orthoclase abounds in igneous rocks and constitutes an important element in granite, gneiss and syenite and in the form of sanidine is common in the volcanic rocks rhyolite, trachyte and phonolite. It is quarried in Maine, Connecticut, Massachusetts and Pennsylvania and at Bedford and Fort Ann N. Y.

Orthoclase is used in the manufacture of porcelain and china, as a constituent of the body of the ware and also to produce the glaze.

[1] These forms of twinning are illustrated by specimens and models in the collection of the New York state museum.

Microcline $KAlSi_3O_8$

Microcline is a triclinic feldspar having the same composition as orthoclase and was formerly grouped under that species. The crystals are so close to those of orthoclase in angle and habit that the unassisted eye is unable to distinguish between the two species. Under the polarizing microscope a characteristic gridiron structure is observable in a thin section of microcline. A characteristic variety called Amazon stone has a beautiful green color. In other respects the characteristics are essentially the same as for orthoclase.

Plagioclase feldspars

The triclinic group of minerals known as the plagioclase feldspars constitute a practically continuous series from pure soda alumina silicate in albite ($NaAlSi_3O_8$) to pure lime alumina silicate, in anorthite ($CaAl_2Si_2O_8$). The intermediate species now to be discussed are mixtures of these two molecules and of necessity grade into one another, so that in many cases no marked division line can be drawn. If the albite molecule, $NaAlSi_3O_8$, be represented by Ab, and the anorthite molecule, $CaAl_2Si_2O_8$, be represented by An, the albite-anorthite series or, as they are usually called, the plagioclase feldspars, may be represented in composition as follows:

Albite	Ab —Ab_6 An_1
Oligoclase	Ab_6 An_1—Ab_3 An_1
Andesin	Ab_3 An_1—Ab_1 An_1
Labradorite	Ab_1 An_1—Ab_1 An_3
Bytownite (rare)	Ab_1 An_3—Ab_1 An_6
Anorthite	Ab_1 An_6—An

The plagioclase feldspars are characterized in general by a repeated twinning parallel to the brachypinacoid which results in a series of striations on the basal cleavage surface. They form an important constituent of the igneous rocks, dacite, andesite, diorite and diabase.

Albite (soda feldspar)

Albite is a silicate of aluminium and sodium.

It occurs in triclinic crystals (fig. 206) often tabular parallel to the brachypinacoid and usually twinned parallel to the

same plane (albite law) or with the macro axis as the twinning axis (pericline law). It is common in pure white granular masses or in aggregations of straight or curved laminae. The luster is vitreous or pearly and the prevailing color white or less commonly bluish, gray, red or green of light tints; an opalescence or play of color is not uncommon on the cleavage surface.

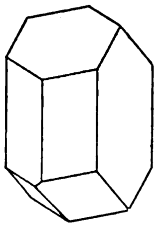


Fig. 206
Albite

Albite is frequently found in cavities and seams in acidic rocks and is frequently a matrix for such minerals as tourmalin, beryl, chrysoberyl, topaz etc. Interesting crystals of albite are found at Moriah, Essex co. N. Y.

Oligoclase (soda lime feldspar)

Oligoclase is a silicate of aluminium, sodium and calcium.

It does not often occur crystallized. Cleavable masses are characterized by the fine striations, common to the plagioclases, but particularly well developed in this species. The luster is vitreous to pearly and the color whitish with faint tints of gray, green, red or yellow.

It occurs with orthoclase and albite in granitoid rocks and in rocks of volcanic origin. Interesting crystals are found in St Lawrence county, N. Y.

Labradorite (lime soda feldspar)

Labradorite is a silicate of aluminium, sodium and calcium. It is rarely found in small triclinic crystals but is commonly met with in dark gray cleavable masses which often display a remarkable change of color as the light is reflected from a cleavage surface. The luster is vitreous to pearly and the color in general darker than that of the other plagioclases.

Labradorite is usually associated with pyroxene and amphibole in many basic rocks. It is the chief feldspar found in the Adirondack region of New York.

Anorthite (lime feldspar)

Anorthite is a silicate of aluminium and calcium. The triclinic crystals of anorthite are usually prismatic in habit, twinned, as with albite, and colorless, white or reddish yellow.

The cleavable masses are pink or gray. Granular masses of a white or reddish color are common.

Anorthite occurs in many volcanic rocks.

Metasilicates

Leucite $KAl(SiO_3)_2$

Leucite is a silicate of potassium and aluminium. It crystallizes in trapezohedrons (fig. 207) and is often found in irregular grains disseminated through lava and volcanic rock. The luster is vitreous and the color light gray or white.

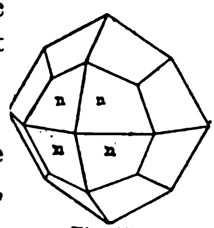


Fig. 207
Leucite

Pyroxene group

The following species though falling in the orthorhombic, monoclinic and triclinic systems, exhibit a marked similarity in crystal habit and in the angle of the fundamental prism, which varies but slightly from 87°. This relation is emphasized by the fact that a more or less pronounced cleavage takes place parallel to this fundamental prism in all species referred to this group.

Enstatite (bronzite) $(MgFe)SiO_3$

Enstatite is essentially a silicate of magnesium but often contains some iron replacing the magnesium. The iron-bearing variety is known as bronzite and grades into hypersthene with increased percentage of iron.

Enstatite rarely occurs in orthorhombic crystals of columnar habit. It is usually found in lamellar or fibrous masses, brown, gray or green in color and in the variety bronzite with a submetallic or bronzelike luster.

It is frequently found in basaltic and granular eruptive rocks and is quite common in stony meteorites. It occurs at Tilly Foster, Putnam co. and at Edwards, St Lawrence co. N. Y.

Hypersthene $(MgFe)SiO_3$

Hypersthene is a silicate of magnesium and iron. With a decreasing proportion of iron hypersthene grades into enstatite. Orthorhombic crystals are rare. The mineral is usually found in dark green to black foliated masses, frequently showing a metalloidal luster somewhat similar to that of bronzite. Hypers-

thene is found in norites and other granular eruptive rocks, a series of which may be found in the vicinity of Peekskill, Westchester co. N. Y.

Pyroxene (augite)

Pyroxene is essentially a normal metasilicate of calcium and magnesium, also containing iron, manganese or zinc and sometimes small percentages of potassium and sodium. The many varieties are usually classified as nonaluminous and aluminous.

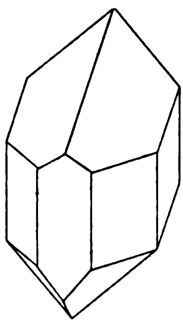


Fig. 208

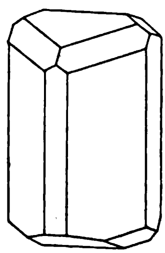


Fig. 209
Pyroxene

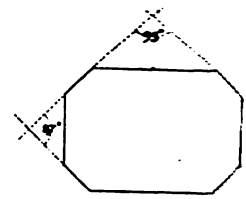


Fig. 210

Pyroxene occurs in monoclinic crystals of prismatic habit with well developed terminations (fig. 208, 209); these crystals have a nearly square or octagonal cross section composed of the faces of the unit prism which has an angle of 93° (nearly 90°) and the faces of the ortho and clino pinacoid (fig. 210). A strongly marked parting parallel to the basal pinacoid is very characteristic, and is well shown in the specimen reproduced in pl.29_1. The crystals are often thick and short. Massive forms are granular, foliated or columnar in structure but rarely fibrous. The luster is vitreous, resinous to dull and the color usually some shade of green, but also white, brown, or black.

VARIETIES

Diopsid or malacolite $CaMg(SiO_3)_2$. Usually white or pale green in color.

Hedenbergite $(CaFe)(SiO_3)_2$. Color grayish green to black.

Augite. An aluminous pyroxene chiefly $CaMg(SiO_3)_2$ but containing aluminium and iron. Color dark green, brownish green to black.

1 Pyroxene, East Russell N. Y.

2 Wollastonite, near Gouverneur N. Y.

Diallage. A foliated variety, green or brown in color.

Pyroxene is an essential constituent of many basic eruptive rocks notably the diabases and gabbros. It occurs associated with amphibole, wernerite and the feldspars. In New York pyroxene occurs in handsome specimens in Orange, Westchester, Essex and Lewis counties and specially in St Lawrence county.

Spodumene $LiAl(SiO_3)_2$

Spodumene is a silicate of lithium and aluminium.

It occurs in monoclinic crystals sometimes of considerable size which are characterized by a lamellar structure parallel to the orthopinacoid causing them to split into broad smooth plates. In the variety hiddenite the crystals are small, transparent and of a yellow-green or emerald-green color. It is also found in cleavable masses. The luster is vitreous and sometimes pearly on the cleavage surfaces, and the color white or various shades of green, pink and purple.

Spodumene occurs in granite rocks and is readily altered. Immense crystals are found at Branchville Ct. The variety hiddenite occurs at Stony Point N. C.

The emerald-green hiddenite is used as a gem.

Jadeite (jade) $NaAl(SiO_3)_2$

This is a tough translucent mineral of closely compact structure and of a general green color. It is chiefly notable as the material from which many of the prehistoric implements were made and is still used in the East, specially in China, for ornaments and utensils.

Wollastonite (tabular spar) $CaSiO_3$

Wollastonite is a silicate of calcium, sometimes occurring in tabular monoclinic crystals, but usually in cleavable to fibrous white or gray masses. When fibrous the fibers lie in parallel position or are arranged in reticulated bundles of parallel fibers (pl. 29_2). The luster is vitreous to silky and the color white or faint tints of gray, yellow, red or brown.

Wollastonite is found in granular limestone and as a contact mineral.

Pectolite $HNaCa_2(SiO_3)_3$

Pectolite is a silicate of sodium and calcium, and contains water.

It usually occurs in radiated aggregates of needlelike crystals which are rarely terminated (pl. 7_1). Monoclinic crystals are rare. The luster is vitreous to silky and the color white or gray.

Pectolite is found associated with the zeolites and prehnite in cavities and seams of basic eruptive rocks.

Rhodonite $MnSiO_3$

Rhodonite is a silicate of manganese with part of the manganese replaced by iron, calcium or zinc.

The crystals of rhodonite are triclinic, tabular parallel to the basal pinacoid, or in forms resembling pyroxene in habit but with rounded edges and angles. It also occurs in cleavable to compact masses and in embedded grains. The luster is vitreous and the color commonly brownish red, flesh-red or pink, less frequently greenish or yellowish.

Rhodonite occurs in the United States in Maine and Massachusetts and abundantly in the vicinity of Franklin N. J.

Amphibole group

This group of minerals is closely allied to the pyroxenes, forming as it does a series whose members are chemically analagous to the corresponding members of a parallel series in the pyroxene group. The two groups are also closely related crystallographically; thus a comparison of the axial ratios of pyroxene and amphibole brings out the fact that if the *a* and *c* unit intercepts for amphibole be multiplied by 2 the result will approximate very closely the actual values of the corresponding intercepts for pyroxene:

PYROXENE	AMPHIBOLE	AMPHIBOLE
a : b : c	a : b : c	2a : b : 2c
1.092 : 1 : 0.589	0.551 : 1 : 1 0.294	1.102 : 1 : 0.588

Amphibole (hornblende)

Amphibole is essentially a metasilicate of calcium and magnesium usually containing iron and manganese and also sodium

and potassium to some extent. As in the case of the pyroxenes the varieties are divided into nonaluminous and aluminous.

Amphibole occurs in monoclinic crystals of prismatic habit, usually with an acute rhombic section and striated vertically; a typical section is shown in fig. 211. Some of the common types

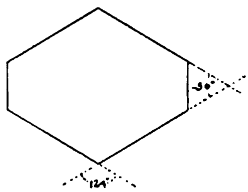


Fig. 211

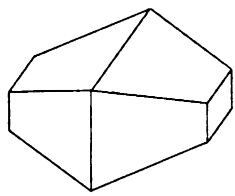


Fig. 212

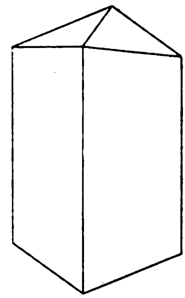


Fig. 213

Amphibole

are given in fig. 212, 213. Columnar and fibrous masses are common, often radiated; also coarse or fine granular masses. The luster is vitreous to pearly and often silky. The color varies with different varieties but is mainly white, shades of green, brown or black.

VARIETIES

Tremolite $CaMg_3(SiO_3)_4$. White or dark gray in color, sometimes transparent and colorless. Luster silky.

Actinolite $Ca(MgFe)_3SiO_3)_4$. Bright green to grayish green in color.

Nephrite (jade). A compact tough variety similar to the jadeite described under pyroxene.

Asbestos. A fine fibrous material white, gray, or greenish in color, easily separated into threadlike fibers.

Hornblende. An aluminous variety. Green, grayish green or black in color.

Amphibole occurs in crystalline limestone and in granitoid and schistose rocks. It is an important constituent of many granites, syenites and diorites. Good specimens have been obtained in Orange, St Lawrence and Lewis counties, N. Y.

Amphibole asbestos, which must not be confounded with the fibrous serpentine passing commercially under the same name,

is mined in California, Wyoming and Oregon. Large deposits also occur in North Carolina, Georgia, Pennsylvania and other states but these deposits are not at present worked with profit.

Asbestos is extensively used for incombustible appliances and fabrics.

Crocidolite (blue asbestos)

This is a blue to green fibrous amphibole resembling asbestos. An altered form from South Africa has the interstices between the fibers filled with silica and under the name of "tiger's eye" is sometimes cut for a cheap gem.

Beryl (emerald) $Be_3Al_2(SiO_3)_6$

Beryl is a silicate of beryllium and aluminium. It occurs in hexagonal crystals of prismatic habit which are often striated

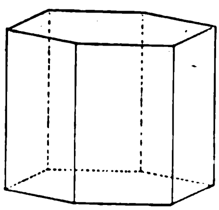


Fig. 214

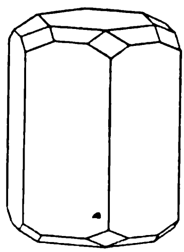


Fig. 215

Beryl

vertically and are seldom terminated (fig. 214, 215). It is also found in columnar or granular masses. The luster is vitreous and the color emerald-green, pale green, light blue, yellowish white, white to colorless.

Beryl is common as an accessory mineral in granite veins. It is also found in mica schist, clay slate, etc. Beryl occurs in Maine, Massachusetts, New Hampshire, Connecticut, North Carolina, South Dakota and other states. The finest emeralds come from United States of Colombia, Brazil, India, Siberia and Australia. A few emeralds have been found at Stony Point S. C.

Emerald and a sky-blue to greenish blue variety called aquamarine are cut as gems.

Iolite (cordierite)

Iolite is a metasilicate of magnesium, aluminium and iron of somewhat complicated formula.

It occurs in short orthorhombic prisms and glassy quartzlike masses of a prevailing blue color which is deeper in one direction and more grayish or yellowish in a direction at right angles to the first.

It occurs in gneiss or granite but rarely in volcanic rocks.

Orthosilicates

Nephelite (nephelin) $K_2Na_6Al_8Si_9O_{34}$

Nephelite is an orthosilicate of sodium, potassium and aluminium.

The crystals are hexagonal-hemimorphic, prismatic in habit, terminated with a basal pinacoid sometimes slightly modified by a low pyramid. The crystals are small, sometimes transparent, with a vitreous luster, and are colorless, white or faintly yellow. Colorless or white glassy grains are found in some eruptive rocks. A common variety, called elaeolite, occurs in indistinct crystals or masses of a peculiar greasy luster and reddish brown or greenish in color.

Nephelite occurs in the more basic igneous rocks as the product of a magma rich in soda. The crystallized variety is found associated with epidote and vesuvianite in lavas and other eruptive rocks, notably in the lavas of Vesuvius. Elaeolite occurs in granular crystalline rocks and is found in Maine, Arkansas, Texas and elsewhere.

Cancrinite

An orthosilicate of sodium, calcium and aluminium generally found in yellow to white masses associated with elaeolite and blue sodalite.

It is found in the Urals, in Norway and at Litchfield and Gardiner Me.

Sodalite $Na_4(AlCl)Al_2(SiO_4)_3$

Sodalite is a chlorosilicate of sodium and aluminium. It is found in bright blue to gray masses of a vitreous to greasy luster, in concentric nodules resembling chalcedony and rarely in isometric dodecahedral crystals.

It is formed from elaeolite and its mode of occurrence is similar to that mineral.

Haüynite $Na_2Ca(NaSo_4.Al)Al_2(SiO_4)_3$

Haüynite is a sodium, calcium and aluminium orthosilicate with some sodium sulfate.

Haüynite occurs in glassy rounded isometric crystals and grains of a blue to green color in igneous rocks and lavas.

Lazurite (lapis lazuli) $Na_4(NaS_3.Al)Al_2(SiO_4)_3$

Lazurite is an orthosilicate of sodium and aluminium with sodium sulfid.

It occurs in deep blue masses and rarely in isometric crystals. Lazurite was formerly used as a natural pigment, producing the deep blue color known as ultramarine; it has now been almost entirely superseded by the artificial product of that name.

Garnet $R^{II}_3R^{III}_2(SiO_4)_3$

Garnet is an orthosilicate of the general formula $R^{II}_3R^{III}_2(SiO_4)_3$ in which R^{II} may be calcium, magnesium, ferrous iron, or manganese and R^{III} aluminium, ferric iron or chromium, rarely titanium. The varying proportions of these elements give rise to numerous varieties, the principal types of which will be discussed under "Varieties."

Garnet crystallizes in the normal group of the isometric system. Fig. 216-18 show the common types of crystals. It occurs

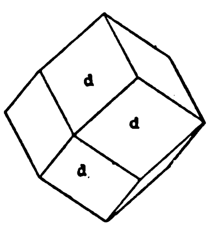


Fig. 216

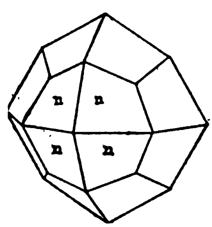


Fig. 217

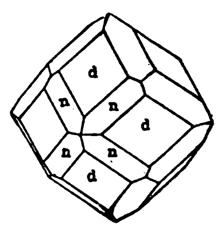
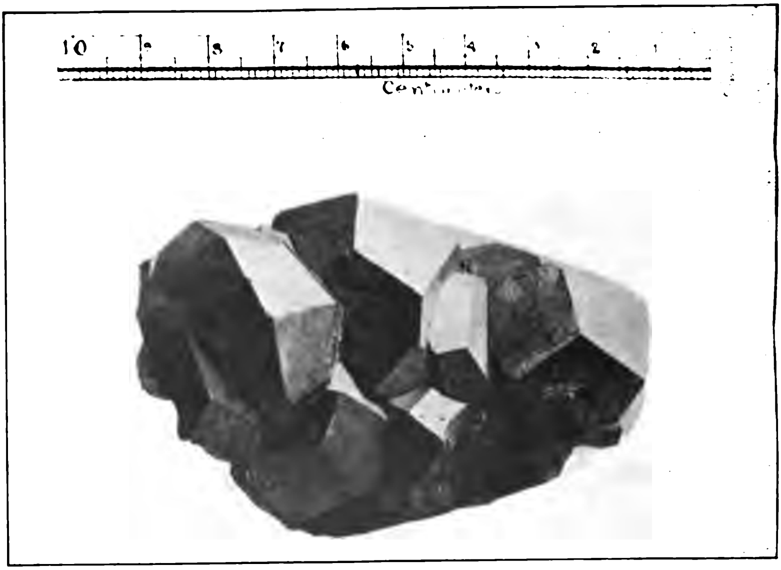


Fig. 218

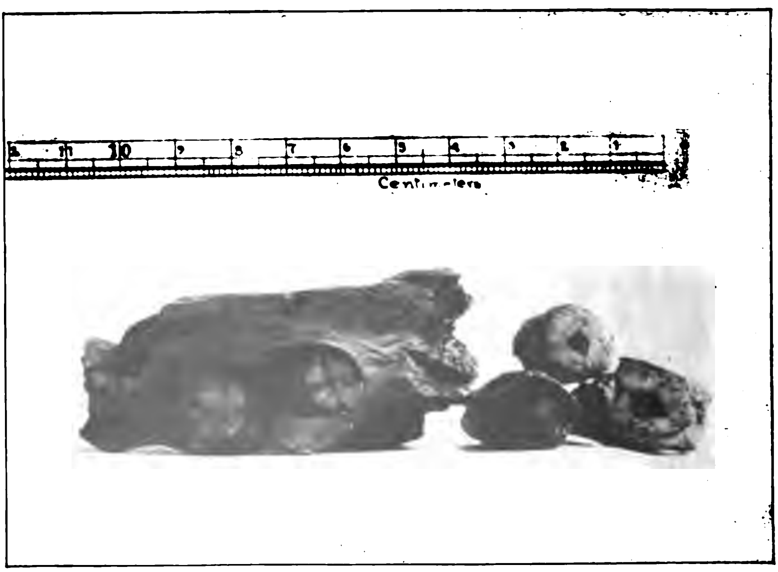
Garnet

in isolated, embedded crystals, in drusy incrustations and in granular, lamellar and compact masses, also as rounded grains and in sand.

The luster is vitreous to resinous and the color commonly brown, red or black but also yellow, pink, white, green and violet. In hardness garnet ranks between quartz and corundum.



1 Garnet, Russell Mass.



2 Andalusite (chiastolite), Lancaster Mass.

VARIETIES

1 Aluminium garnet. Grossularite $Ca_3Al_2(SiO_4)_3$. White, pale yellow, pale green, reddish, brown or rose-red in color, rarely emerald-green from the presence of chromium.

Pyrope $Mg_3Al_2(SiO_4)_3$. Deep red to nearly black in color. Transparent specimens are cut for gems.

Almandite $Fe_3Al_2(SiO_4)_3$. Deep red to black in color. This variety includes many of the common garnets and when transparent is cut for gems.

Spessartite $Mn_3Al_2(SiO_4)_3$. Dark hyacinth-red, violet-red to brownish red.

2 Iron garnet. Andradite $Ca_3Fe_2(SiO_4)_3$. Various shades of yellow, green, red, brown and black in color. This variety is quite common.

3 Chromium garnet. Uvarovite $Ca_3Cr_2(SiO_4)_3$. In minute crystals of an emerald-green color.

Garnet, particularly the variety almandite, occurs abundantly in gneiss and the crystalline schists. Grossularite is characteristic of the contact zones of intruded igneous rock in the crystalline schists. Pyrope is found in many basic igneous rocks, and spessartite in granite rocks, quartzites and whetstone schists, also in rhyolite. Uvarovite is found with chromite in serpentine and in granular limestone. Pink garnets embedded in marble are found at Mordos Mex. In New York garnet is found in Essex, Warren, Orange, Westchester and New York counties.

Garnet is extensively used as abrasive material. The Mexican marble mentioned above is polished for ornamental purposes and transparent red and green varieties are cut for gems.

Chrysolite (olivin, peridot) $(Mg.Fe)_2SiO_4$

Chrysolite is an orthosilicate of magnesium and iron. It rarely occurs in orthorhombic crystals but is usually found in transparent to translucent granular masses, disseminated grains or as sand. The luster of chrysolite is vitreous and the color a yellowish green, olive-green, or bottle-green to brownish red.

Chrysolite occurs as an essential constituent of peridotite and of some gabbros. It is found in eruptive rocks such as trap, basalt, etc. and as a product of the metamorphism of certain sedimentary rocks containing magnesia and silica.

As a rock constituent chrysolite occurs in the rocks of the Cortlandt series in the vicinity of Peekskill, Westchester co. and Stony Point, Rockland co. N. Y.

Transparent varieties of olivin are cut as gems and are known to jewelers as olivins or peridots.

Willemite Zn_2SiO_4

Willemite is an orthosilicate of zinc containing 72.9% zinc oxid and 27.1% silica. A considerable part of the zinc is replaced by manganese in the variety troostite.

Willemite occurs in hexagonal crystals of the trirhombohedral class prismatic in habit. It is more commonly found in granular masses and disseminated grains. The luster is resinous and the color greenish yellow to apple-green when pure but flesh-red in the manganese bearing variety.

Willemite is chiefly found associated with franklinite and zincite in the vicinity of Franklin N.J. where it is mined for zinc.

Phenacite Be_2SiO_4

Phenacite is the orthosilicate of beryllium. It occurs in transparent hexagonal crystals, trirhombohedral, which are commonly small, lens-shaped and transparent and white or yellowish in color.

It occurs with microcline, beryl, quartz and topaz and is found in the Urals, in Mexico and at Pike's peak Col. It is sometimes cut for an imitation gem.

Dioptase H_2CuSiO_4

Dioptase is a basic copper orthosilicate occurring in rhombohedral crystals and crystalline aggregates of a vitreous luster and emerald-green in color; also massive.

Wernerite (scapolite)

Wernerite is an aluminium, sodium and calcium chlorosilicate of variable composition, usually containing some soda.

The crystals of wernerite are tetragonal, of the general type shown in fig. 219, and are characterized by the low pyramidal termination. They are commonly coarse and thick, often with rounded edges and angles and with a characteristic fibrous appearance on the cleavage surfaces. Wernerite also occurs in

columnar and granular masses. The luster is vitreous to dull, and the color is usually gray, dull green or white, sometimes bluish or reddish.

Wernerite occurs in metamorphic rocks and is abundant in granular limestone near the contact with granite or other igneous rocks. It is associated with pyroxene, amphibole, apatite, etc. In New York wernerite is found in Orange, Essex and Lewis counties and abundantly in Jefferson and St Lawrence counties.

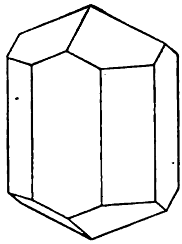


Fig. 219
Wernerite

Vesuvianite (idocrase)

Vesuvianite is a basic calcium-aluminium silicate of uncertain formula with some of the calcium replaced by manganese and some of the aluminium by iron. Fluorin and titanium may be present.

The crystals are tetragonal, prismatic or pyramidal in habit, the prismatic crystals often exhibiting the general type shown in fig. 220. Columnar masses occur straight, radiated or irregular, often producing characteristic striations parallel to the vertical axis. The luster is vitreous to resinous and the color commonly brown, green or some intermediate shade, rarely yellow or blue.

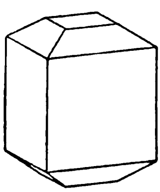


Fig. 220
Vesuvianite

Vesuvianite commonly occurs as a contact mineral from the alteration of impure limestone; also in serpentine, chlorite schist, gneiss and other metamorphic rocks; in the former case it is usually associated with garnet, phlogopite, pyroxene, wollastonite, etc. It is found in Canada, Maine, New Hampshire and New Jersey and in Orange county and other localities in New York.

Zircon (hyacinth) $ZrSiO_4$

Zircon is a silicate of zirconium usually containing a little iron sesquioxid.

It occurs in tetragonal crystals, prismatic in habit, of the general types shown in fig. 221–23, but sometimes pyramidal with the prism only slightly developed. Twins similar to those of cassiterite and rutile occur. Zircon is also found in irregular lumps and grains. The luster is adamantine and the color

usually brown, reddish or gray but also colorless, green or yellow. Zircon is somewhat harder than quartz.

Zircon occurs chiefly in granite, gneiss, crystalline limestone and other crystalline rocks and in alluvial deposits; often in auriferous sands; sometimes also in volcanic rocks. Interesting specimens of zircon have been found in Orange, Essex and St Lawrence counties, N. Y. It is mined in North Carolina.

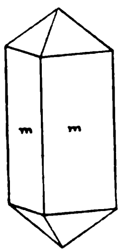


Fig. 221

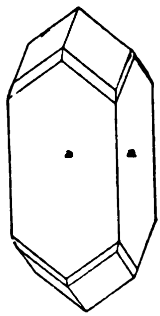


Fig. 222

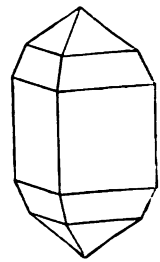


Fig. 223

Zircon

Zircon is the chief source of zirconium oxid used in certain incandescent light mantles. Transparent red and brown varieties are cut as gems and are known to jewelers as hyacinth, a term also used in connection with garnet.

Topaz $Al_{12}Si_6O_{25}F_{10}$

Topaz is an aluminium fluosilicate.

The crystals are orthorhombic, prismatic in habit, frequently with complicated terminations (fig. 224, 225) and often striated

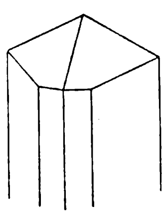


Fig. 224

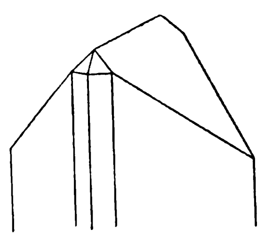


Fig. 225

Topaz

vertically on the prismatic faces. They show perfect cleavage parallel to the base, the cleavage surfaces presenting beautifully polished reflecting planes. They are usually attached and

are consequently rarely terminated at both ends. Topaz occurs also in columnar masses and rolled fragments.

The luster is vitreous and resembles that of quartz; the crystals are colorless, yellow, reddish, bluish, faintly green or pink; massive varieties are often white. The hardness exceeds that of quartz but is not as high as corundum.

Topaz occurs in veins and cavities in the highly acid igneous rocks such as granite, rhyolite, etc. and sometimes in gneiss and schists. It is often found in alluvial deposits with stream tin. It is commonly associated with fluorite, cassiterite and tourmalin.

It is found in Saxony, the Urals, Japan, Brazil, Mexico; and in Maine, Colorado and Utah.

Transparent varieties are cut for gems.

Andalusite Al_2SiO_5

Andalusite is an orthosilicate of aluminium.

It occurs in coarse orthorhombic crystals nearly square in cross section or in tough columnar or granular masses. The variety chiastolite occurs in rounded prisms which are characterized by carbonaceous inclusions symmetrically arranged with respect to the vertical axis; these show on a fracture, a cross or tesselated figure as in pl. 30_2. The luster is vitreous inclining to pearly; the color varies from white or light gray through light green or violet to rose-red or flesh-red.

Andalusite occurs in imperfectly crystalline schist, in gneiss, mica schist and other metamorphic rocks. Chiastolite is commonly a contact mineral in clay slates adjoining granite dikes. It is found in Andalusia, Spain; Brazil and in many localities in the New England states, Pennsylvania and California.

Sillimanite (fibrolite) Al_2SiO_5

An orthosilicate of aluminium with the same composition as andalusite. It occurs in long slender orthorhombic crystals, in parallel groups passing into fibrous or columnar masses, brown or gray in color and extremely tough in tenacity. Its mode of occurrence is similar to that of andalusite.

Cyanite (disthene) Al_2SiO_5

Cyanite is probably a basic metasilicate of aluminium with the formula $(AlO)_2SiO_3$. Dana, however, places it for convenience in the group with sillimanite, to which mineral it bears a close relation.

Cyanite is found in long bladelike, triclinic crystals which are rarely terminated and in coarsely bladed columnar masses usually of a grayish blue color (pl. 2_2). It cleaves easily parallel to the three pinacoids. The luster is vitreous to pearly and the color commonly blue along the center of the blades, shading to white on the edges; also gray, green to nearly black.

It occurs in gneiss and mica schist with garnet and staurolite and is often associated with corundum. It is found in the corundum regions of Massachusetts, Pennsylvania, North Carolina and Georgia; it has been noted in the rocks of New York island.

Cyanite is sometimes used as a gem.

Datolite $Ca(BOH)SiO_4$

Datolite is a basic calcium and boron orthosilicate.

It crystallizes in monoclinic forms of varied habit but usually short prismatic (fig. 226) and often highly modified. The crystals are glassy, transparent or translucent and colorless, white or pale green. A massive compact variety has a dull luster resembling unglazed porcelain and is gray or pinkish in color.

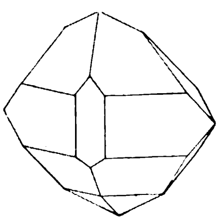


Fig. 226
Datolite

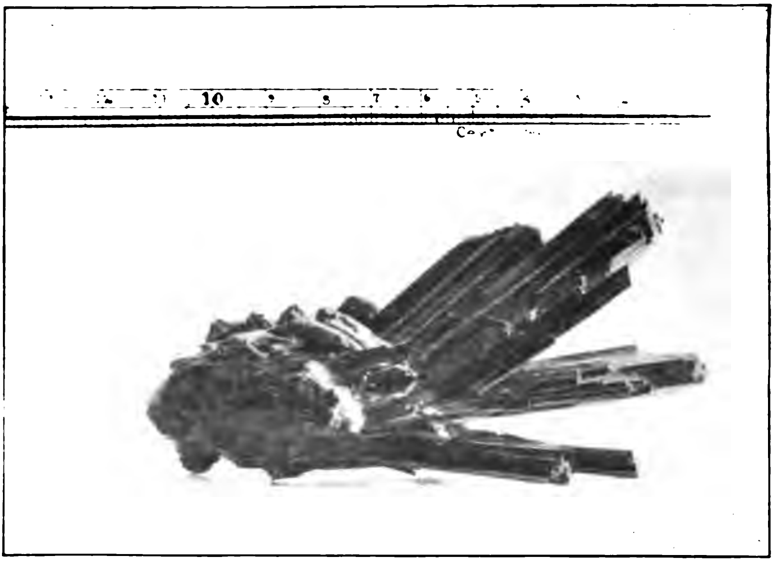
Datolite occurs as a secondary mineral in veins and cavities in basic eruptive rocks associated with calcite, prehnite and the zeolites; also in metallic veins as in the Lake Superior copper region where the massive variety is quite common. It is also found in the vicinity of Bergen Hill and Paterson N. J. and in other localities throughout New York[1] and New England.

Epidote $HCa_2(Al,Fe)_3Si_3O_{13}$

Epidote is a basic calcium, aluminium and iron silicate.

It occurs in monoclinic crystals which are commonly elongated

[1] A few rare occurrences are noted in St Lawrence county. *See* Dana, J. D. System of mineralogy. 1892.



1 Epidote, Sulzbach, Tyrol

2 Prehnite, West Paterson N. J.

in the direction of the orthoaxis producing forms of horizontal prismatic habit (fig. 227). These pass into acicular forms, striated in the direction of elongation, columnar, parallel or divergent, and fibrous masses (pl. 31_1). It also occurs coarse to fine granular. The luster is vitreous, the crystals sharp and with brilliantly reflecting faces; the color is commonly some shade of pistachio-green, often nearly black, also yellowish green, gray or brown.

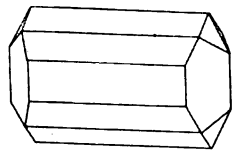


Fig. 227
Epidote

Epidote occurs in metamorphic rocks of the older formations, in gneiss, mica and hornblende schists. It is found associated with quartz, the feldspars, actinolite and minerals of the chlorite group. It is common in New England and in many of the western states. Handsome specimens have been found in Orange and Putnam counties, N. Y.

Axinite $H_2Ca_4(BO)Al_3(SiO_4)_5$ (?)

Axinite is an aluminium and calcium borosilicate with some of the calcium replaced by iron and manganese. It occurs in sharp triclinic crystals with acute edges (fig. 228), clove-brown, bluish or yellow in color and in lamellar and curved lamellar masses. The luster is highly vitreous.

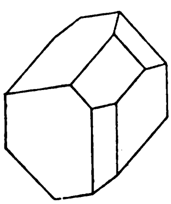


Fig. 228
Axinite

Prehnite $H_2Ca_2Al_2(SiO_4)_3$

Prehnite is an acid calcium and aluminium orthosilicate.

It is rarely found in isolated orthorhombic crystals of tabular habit but usually occurs in aggregates of such crystals united by their basal planes and producing barrellike, sheaflike and botryoidal shapes (pl. 31_2) with crystalline surfaces. The luster is vitreous, faint pearly on the basal planes; the color is light green to oil green, yellowish green, gray to white.

Prehnite occurs as a secondary mineral in veins and cavities in basic eruptive rocks, basalt, diabase, etc. also in gneiss and granite associated with calcite, pectolite, datolite and the zeolites. It is sometimes associated with the copper of the Lake Superior region. Beautiful specimens are found in the neighborhood of Bergen Hill and Paterson N. J.

It is occasionally cut as a gem.

Subsilicates

The minerals here included are probably either metasilicates or orthosilicates, which, for lack of definite knowledge regarding their constitution, have been classed by Dana under this head.

Humite group

This group includes the species chondrodite, humite and clinohumite. They are basic fluosilicates of magnesium and are closely related chemically. They occur in crystals which are extremely complicated (chondrodite and clinohumite are monoclinic, and humite is orthorhombic). Clinohumite and chondrodite occur in compact masses and disseminated grains. A vitreous to resinous luster is common to the group and the general color is red, brownish red, brown to yellow.

The humite group occur mainly in ejected masses of limestone and are associated with chrysolite, biotite, pyroxene, magnetite, spinel, etc. The minerals of the humite group are all found at the Tilly Foster mine, Putnam co. N. Y.

Calamin H_2ZnSiO_5

Calamin is a basic zinc silicate containing 67.5% zinc oxid, 25% silica and 7.5% water.

The crystals are orthorhombic-hemimorphic, usually tabular parallel to the brachypinacoid (fig. 229) and are frequently joined in radiated groups forming a rounded notched ridge or cockscomb (pl. 32_1). Granular, stalactitic and botryoidal masses are also found. The luster is vitreous to pearly. Isolated crystals are occasionally colorless and transparent; in general the color is white, more rarely delicate shades of blue or green and yellow to brown in the massive varieties.

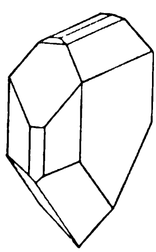


Fig. 229
Calamin

Calamin usually accompanies smithsonite in veins and cavities in stratified calcareous rocks associated with the sulfids of zinc, iron and lead. It is mined in considerable amounts in Silesia and Rhenish Germany. In the United States it occurs extensively at Granby Mo.; also at Sterling Hill N. J., Bethlehem Pa. and in Virginia, Pennsylvania, Utah and Montana.

As an ore of zinc it is valued as being comparatively free from volatile impurities.

1 Calamin, Franklin N. J.

2 Tourmalin (rubellite) on lepidolite, San Diego county, Cal.

Tourmalin (schorl)

Tourmalin is a complex silicate of boron and aluminium with appreciable amounts of either magnesium, iron or the alkali metals.

It crystallizes in the rhombohedral-hemimorphic class of the hexagonal system in prismatic crystals, sometimes short and thick as in fig. 230 or elongated with vertical striations, but

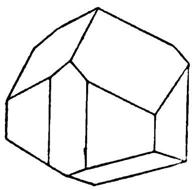


Fig. 230

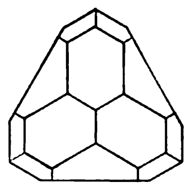


Fig. 231

Tourmalin

always presenting a somewhat triangular cross section (fig. 231). Where doubly terminated the crystals show different modifications on the two extremities. Parallel or radiated crystal aggregates are common as well as columnar and compact masses (pl. 32_2). The luster is vitreous to resinous; the color is commonly black, brown or bluish, also blue, green, pink, or red, rarely colorless or white. Some varieties are composed of an internal core of red surrounded by a layer of green, others are differently colored at the opposite extremities.

Tourmalin occurs in crystalline rocks such as granite, gneiss, mica schist, crystalline limestone, etc. The brown variety is generally found in granular limestone and dolomite; a bluish black kind is often associated with the tin ores; black tourmalins are common in quartz, granite, gneiss and mica schist; rubellite, a pink to red variety, is found in lepidolite. In New York tourmalin is found in handsome specimens in St Lawrence county; at Gouverneur and Pierrepont; also in Essex, Orange and New York counties.

Transparent varieties are sometimes cut as gems or for use in certain optical apparatus.

Staurolite $HFeAl_5Si_2O_{13}$

Staurolite is a basic iron and aluminium silicate with magnesium (and sometimes manganese) replacing part of the ferrous iron.

It occurs in orthorhombic crystals of prismatic habit which are often twinned, producing crosslike forms (pl. 33_1). The luster is resinous to vitreous and the color varies from a blackish brown to dark brown or gray.

Staurolite is usually found in metamorphic rocks such as gneiss, mica schist and argillaceous schists as a result of regional metamorphism and is frequently associated with garnet, sillimanite, cyanite and tourmalin. It occurs throughout the mica schists of New England, in North Carolina and Georgia. A few occurrences are noted in the mica schists of New York as the result of contact metamorphism, as at Peekskill, Westchester co.[1]

Hydrous silicates

The species here included contain water of crystallization, as is the case with the zeolites, or yield, on ignition, water which is present as a base; in the latter category belong the micas and talc. In a third type of silicates referred to this division the relation of the water contained to the general composition is still in doubt.

Zeolite division

Apophyllite $H_7KCa_4(SiO_3)_8+4\frac{1}{2}H_2O$

Apophyllite is a hydrous potassium and calcium silicate.

It occurs in tetragonal crystals, mostly of square cross section, sometimes flattened in the direction of the vertical axis into plates; and in rectangular forms, somewhat isometric in aspect but striated on the prismatic faces and giving pearly reflections from the basal plane (pl. 33_2); it is often found with steep pyramidal terminations (fig. 232). It is also found occasionally in lamellar masses. The luster is vitreous except on the basal pinacoid which face has a pearly luster with internal opalescence often likened to the eye of a fish; it is colorless, white, pink or greenish.

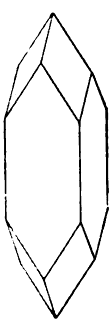
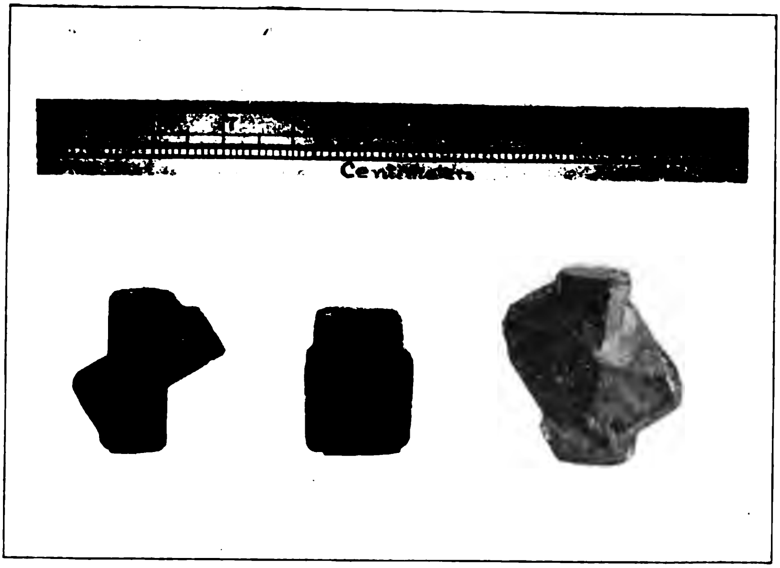


Fig. 232
Apophyllite

Apophyllite occurs as a secondary mineral in basalt and other volcanic rocks associated with the zeolites, datolite, prehnite, and calcite; also in cavities in granite and gneiss. Nova Scotia, the Lake Superior copper region and Bergen Hill N. J. afford many good specimens.

[1] Williams, G. H. Contact metamorphism near Peekskill N. Y. Am. jour. sci. 1888. 36:254.



1 Staurolite, Fanning county, Ga.

2 Apophyllite, West Paterson N. J.

1 Stilbite, Partridge Island N. S.

2 Natrolite, Weehawken N. J.

Heulandite $H_2CaAl_2(SiO_3)_6+3H_2O$

Heulandite is a hydrous calcium and aluminum silicate.

It occurs in monoclinic crystals, somewhat coffinlike in shape with marked cleavage parallel to the clinopinacoid and a pearly luster on the clinopinacoid and cleavage surfaces. The crystals are sometimes joined in parallel position, giving ridgelike forms of the general coffinlike section. The luster is pearly to vitreous and the color white, red or brown.

Heulandite occurs with the other zeolites in basaltic rocks and gneiss. For localities see apophyllite.

Stilbite (desmine) $H_4(Na_2.Ca)Al_2(SiO_3)_6+4H_2O$

Stilbite is a hydrous sodium, calcium and aluminium silicate.

It occurs in monoclinic crystals resembling those of heulandite but usually more tabular parallel to the clinopinacoid and with a more strongly marked tendency to form aggregates which are sheaflike (pl. 34_1), globular or radiated in form. The broad faces of the tabular crystals show a pearly luster, otherwise the luster is vitreous; the color is white, red, brown or yellow.

Stilbite occurs in the formations and localities common to the zeolites, for which see apophyllite.

Chabazite $(Ca,Na_2)Al_2(SiO_3)_4+6H_2O$

Chabazite is a hydrous calcium, sodium and aluminium silicate.

It occurs in rhombohedral crystals with nearly square faces, which give them somewhat the aspect of cubes. These faces, however, are commonly striated parallel to the edges and are often broken by the protuberance of an angle of the twinned negative rhombohedron. The luster is vitreous and the color white or flesh-red.

Chabazite like the other zeolites is found generally in basaltic rocks. It is abundant in several localities in Nova Scotia.

Analcite $NaAl(SiO_3)_2+H_2O$

Analcite is a hydrous sodium and aluminium silicate.

It occurs in isometric crystals, usually trapezohedrons (fig. 233). A variety from the Cyclopean islands near Sicily is cubic in habit with small trapezohedral modifications. It is sometimes found in concentric groups about a single crystal as a

nucleus and more rarely in granular or compact masses with concentric structure. The luster is vitreous and the crystals are colorless or white, greenish or faintly red in color.

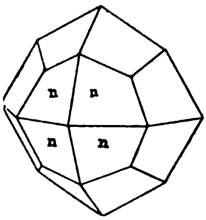


Fig. 233
Analcite

Analcite is a secondary mineral occurring with other zeolites in the basalt or gneiss at the prominent zeolite localities previously given under apophyllite.

Natrolite $Na_2Al_2Si_3O_{10}+2H_2O$

Natrolite is a hydrous sodium and aluminium silicate.

It occurs in slender, orthorhombic prisms of nearly square cross section often terminated by a flat pyramid (fig. 234); these are commonly grouped in radiating and interlacing aggregates (pl. 34_2). It also occurs in radiating fibrous forms and granular to compact masses. The luster is vitreous; the color is white, greenish or reddish, the crystals are frequently colorless.

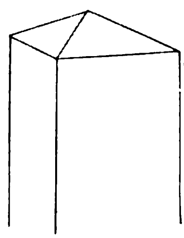


Fig. 234
Natrolite

The manner of occurrence, association and localities are the same as for the other zeolites.

Mica division

Muscovite (common mica, isinglass) $H_2KAl_3(SiO_4)_3$

Muscovite is a hydrous potassium and aluminium orthosilicate.

The crystals of muscovite are monoclinic, prismatic and tabular in habit, with a rhombic or hexagonal section and cleave with great ease parallel to the base into extremely thin elastic plates. It also occurs in disseminated scales, often grouped in globular (pl. 35_1) or plumose (pl. 35_2) forms. The luster of muscovite is vitreous, pearly on the cleavage planes; the color is commonly gray, brown, green or yellow, sometimes violet or black.

Muscovite is the most common of the micas and is very widely distributed. It is an essential constituent of mica schist and, to a less degree, of some granite and gneiss. The best developed crystals occur in pegmatite dikes and veins. It is also found in fragmental rocks and limestones but rarely as a secondary mineral in volcanic rocks.

1 Muscovite, Stowe Me.

2 Muscovite (plumose), Minot Me.

Muscovite is mined in South Carolina and New Hampshire. Deposits of good quality also exist in Pennsylvania, Colorado, Nevada, New Mexico, South Dakota, Washington and California. Muscovite has been found in Westchester, Orange, Jefferson and St Lawrence counties, N. Y.

Muscovite, known commercially as mica and colloquially as isinglass, is much used for the doors of furnaces and stoves, also as an insulating material in dynamos and other electric appliances and for many less important purposes.

Lepidolite (lithia mica)

Lepidolite is a basic fluosilicate of potassium lithium and aluminium. It occurs in crystalline plates resembling those of muscovite but of a pinkish or violet-gray color often nearly white. More frequently it is found in massive granular aggregates of coarse or fine scales. It cleaves easily parallel to the base into elastic plates. It is distinguished from muscovite mainly by the color.

It is found in granite and gneiss particularly in pegmatite veins.

Biotite (black mica) $(H,K)_2(Mg,Fe^{II})_2(Al,Fe^{III})_2(SiO_4)_3$

Biotite is a potassium, magnesium, aluminium, ferrous and ferric iron orthosilicate.

It occurs in monoclinic crystals, tabular or short prismatic in habit, similar to those of muscovite. These show the basal cleavage characteristic of the micas, separating into thin elastic plates. It is often found in disseminated scales or in massive aggregates of cleavable scales. The luster is vitreous, pearly, or, in the dark colored varieties, submetallic; the color is commonly dark green to black.

Biotite occurs as an important constituent in many igneous rocks and is common in most granites, and in many syenites and diorites; also in such eruptive rocks as rhyolite, trachyte and andesite. In small flakes biotite is present in many common rocks and soils.

Orange, Essex and St Lawrence counties, N. Y. furnish good specimens.

Phlogopite (amber mica) $(H,K,MgF)_3Mg_3Al(SiO_4)_3$

Phlogopite is a potassium, magnesium and aluminium fluosilicate.

The crystals of phlogopite are similar to those of muscovite and biotite but are often developed into rather longer prismatic forms usually tapering slightly at either end. The color is commonly yellowish brown to brownish red, frequently a metallic copper-red on the cleavage surfaces.

It is specially characteristic of crystalline limestone and is also found in serpentine. Localities are numerous throughout New York, particularly in Jefferson and St Lawrence counties, and in New Jersey.

Phlogopite is used largely as an insulating material in electric work.

Clinochlore (ripidolite) $H_8Mg_5Al_2Si_3O_{18}$

Clinochlore is a basic magnesium and aluminium silicate.

It occurs in monoclinic crystals closely approximating hexagonal forms in prism angle. The crystals cleave easily into thin, inelastic plates resembling those of the micas. It is also found in masses of coarse or fine scales and in an earthy variety. In color clinochlore is commonly some shade of green, more rarely yellowish, white or rose-red.

It is frequently found in chlorite and talcose rocks and in serpentine. Clinochlore partly altered to serpentine occurs with magnetite at Brewster, Putnam co. N. Y.

Prochlorite $H_{40}(FeMg)_{23}Al_{14}Si_{13}O_{90}$

Prochlorite is a basic magnesium and aluminium silicate with some iron and a lower percentage of silica than clinochlore.

It is monoclinic, the crystals are commonly small with strongly furrowed prismatic faces and often curiously twisted into wormlike shapes. It is also found in foliated and granular masses. The color varies from grass-green to blackish green and the luster from feebly pearly to dull.

It frequently results from the decomposition of mica, amphibole, garnet, pyroxene, etc. Its association and occurrence are similar to clinochlore.

Serpentine and talc division

Serpentine $H_4Mg_3Si_2O_9$

Serpentine is a hydrous magnesium silicate with some of the magnesium replaced by iron.

Serpentine occurs only in massive forms and in pseudomorphs after crystals of chrysolite, amphibole, pyroxene, enstatite, etc. It is sometimes foliated but also occurs in delicate silky fibers (pl. 3_1) and in fine granular to impalpable masses. It is characterized by a greasy feel. The color is green of various shades, yellow, brown, red, black and nearly white, often gray on exposure and frequently variegated. The luster is greasy, silky or waxy.

Serpentine is a secondary mineral resulting from the alteration of certain magnesium silicates and frequently forms large rock masses. When formed from the alteration of basic igneous rocks it is associated with spinel, garnet, chromite and sometimes ores of nickel. The variety derived from the decomposition of metamorphic rocks is commonly accompanied by dolomite, magnesite and other carbonates. A variegated rock of the latter type is polished for ornamental purposes and goes by the name of verd antique marble; this is quarried at Milford Ct. A fibrous variety known as chrysotile is mined in Quebec and is used as asbestos. Outcrops of serpentine are found in Westchester county at New Rochelle, Rye and Port Chester, and in Putnam, Orange, Richmond, Jefferson and St Lawrence counties, N. Y.

Talc (steatite, soapstone) $H_2Mg_3(SiO_3)_4$

Talc is an acid metasilicate of magnesium.

Owing to the extreme rarity of crystallized specimens its system of crystallization is still in doubt. It commonly occurs in foliated or fibrous masses (pl. 3_2), sometimes with a stellated structure, and in coarse or fine granular to compact masses. These vary in hardness (H1–1.5) but are in general very soft with a soapy feel. The color is ordinarily white, greenish or gray and the luster pearly or waxy.

VARIETIES

Foliated talc. A light green to white foliated variety which may be separated into thin, inelastic plates.

Soapstone or steatite. A coarse to fine granular talc of a gray or green color; used extensively for making sinks and as a refractory material for hearths, stove linings, etc.

French chalk. A soft compact material used by tailors for marking cloth.

Agolite. A fibrous variety of talc somewhat above the average hardness and used when mixed with wood pulp in the manufacture of paper.

Rensselaerite. A name given to the pseudomorphs of talc after pyroxene.

Talc in the form of soapstone is very common, and in some regions constitutes quite extensive beds. It is often associated with serpentine, chlorite schist and dolomite and frequently forms pseudomorphs after other minerals. An extensive deposit at Talcville, St Lawrence co. N. Y. is mined for the manufacture of paper and for a fireproof fiber which is mixed with serpentine asbestos.[1]

Besides the uses above mentioned talc is used in making soap, as a dressing for skins and as a lubricant.

Sepiolite (meerschaum) $H_4Mg_2Si_3O_{10}$

Sepiolite is a silicate of magnesium containing water. It occurs in soft, compact, white, amorphous masses of an earthy texture and with a dull luster. It is rarely fibrous.

Sepiolite is found in Asia Minor, Greece, Morocco, Moravia and in Spain where it is used as a building stone. The material from Asia Minor is used for making meerschaum pipes.

Kaolin division

Kaolinite (kaolin) $H_4Al_2Si_2O_9$

Kaolinite is a basic aluminium silicate with some iron and organic matter.

It occurs in small scalelike pearly monoclinic crystals, more commonly in compact or loose masses of a claylike nature. The color is white, grayish, yellowish and sometimes brownish, bluish or reddish. The common massive material is plastic and unctuous to the touch.

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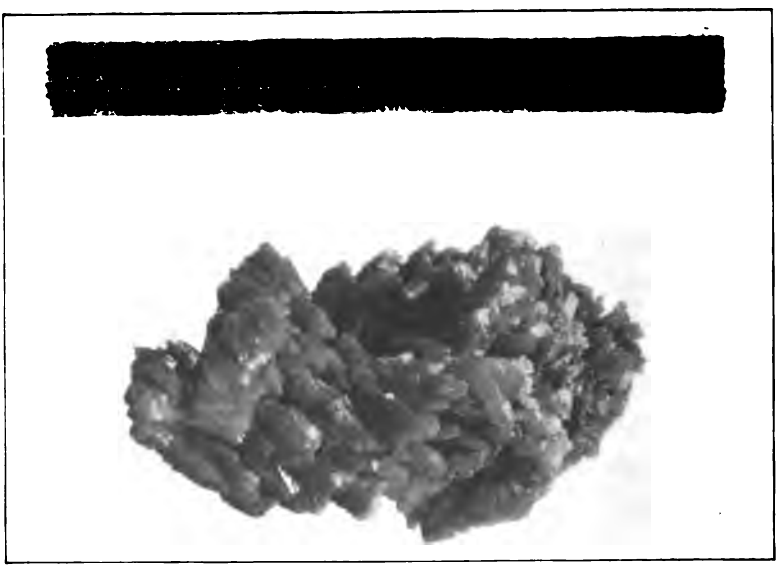
[1]Nevius, J. N. Talc industry of St Lawrence county, N. Y. N. Y. state mus. 51st an. rep't. 1897. 1:119-27.

1 Pyrophyllite, Lincoln county, Ga.



2 Pyromorphite, Ems, Germany

Kaolin is of secondary origin resulting from a decomposition of the feldspars and other silicates. It occurs associated with the feldspars, corundum, topaz, etc. Notable deposits occur in China, Belgium, France, Bavaria and Cornwall. In the United States kaolin is mined in Florida, North Carolina, Delaware, Pennsylvania, and in somewhat poorer quality in Ohio, New Jersey, New York and other states.

As a constituent of porcelain, chinaware, tiling and similar products its importance is constantly increasing.[1]

Pyrophyllite (pencil stone) $H_2Al_2(SiO_3)_4$

Pyrophyllite is a basic aluminium silicate.

It occurs in radiated, lamellar or fibrous masses, sometimes compact and smooth, soft and soapy like talc (pl. 36_1). The luster is pearly to dull and the color white, greenish, brownish or yellow.

The compact variety is present in some schistose rocks and the foliated form often occurs associated with cyanite. Pyrophyllite is found in North Carolina, South Carolina and Georgia.

It is extensively used for slate pencils.

Chrysocolla $CuSiO_3+2H_2O$

Chrysocolla is a hydrous copper silicate containing 34.3% silica, 45.2% copper oxid and 20.5% water. It is often very impure.

Chrysocolla is found in green to blue masses with an enamel-like texture; sometimes botryoidal; incrusting or filling seams. Impure varieties often occur in earthy masses, green or dull brown in color.

It occurs associated with other copper minerals specially in the upper parts of veins and is to be found in most of the copper producing regions.

It is an ore of copper and is also used for imitation turquoise.

Titano-silicates, Titanates

Titanite (sphene) $CaTiSiO_5$

Titanite is a calcium titano-silicate often carrying iron in varying amounts and sometimes manganese and yttrium.

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[1] For an exhaustive treatise on this subject *see* N. Y. state mus. Bul. 35. 1900.

The crystals of titanite are monoclinic and very varied in form; commonly of a wedge-shaped or tabular type (fig. 235) but often prismatic in habit. Compact massive forms also occur but lamellar varieties are rare. The luster is adamantine or resinous and the color usually brown to black, yellow or green, rarely rose-red.

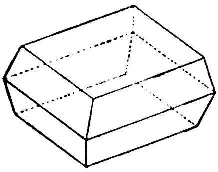


Fig. 235
Titanite

Titanite occurs as an accessory rock-forming mineral in many igneous rocks, mostly of the acidic feldspathic type and is more common in plutonic granular than in the volcanic forms. It is found in basic hornblende granites, syenites and diorites and is very characteristic of the nephelin schists, gneisses, etc.; also in granular limestone and in beds of iron ore. It is commonly associated with pyroxene, amphibole, wernerite, zircon, apatite, etc. and when found in cavities in granite and gneiss often accompanies orthoclase and quartz.

Handsome specimens are to be found in Ottawa and Renfrew counties, Canada, and in New York in the Lake George region of Essex county and in St Lawrence, Lewis, Orange and Putnam counties. Transparent varieties are cut for gems.

NIOBATES, TANTALATES

Columbite, tantalite

The species columbite, an iron and manganese niobate, and tantalite, an iron tantalate, grade into each other chemically to such an extent that it is impossible to definitely separate the two species. The normal formula for columbite is (Fe, Mn) Nb_2O_6 and that for normal tantalite is $FeTa_2O_6$. The iron and manganese vary widely and tin and wolfram are also often present in small amounts.

The crystals which are orthorhombic are of varied habit, sometimes occurring in short prismatic forms or in tabular prismatic crystals flattened parallel to the macropinacoid. Heart-shaped twins are quite common. It also occurs massive. The luster is submetallic, often very brilliant, and the color black in opaque varieties or brown in the more translucent occurrences. It is frequently iridescent, particularly on the surfaces produced by cleavage, which occurs in two directions at right angles.

Columbite often occurs in granite and pegmatite veins, in mica, and, in the Greenland locality, in cryolite; it has been found in gold washings in the Urals. In the United States it is found in Maine, New Hampshire, Massachusetts, Connecticut, New York, Pennsylvania, Virginia, North Carolina, Colorado, South Dakota and California.

PHOSPHATES, ARSENATES, VANADATES, ANTIMONATES

Monazite $(Ce,La,Di)PO_4$

Monazite is a phosphate of the cerium metals, with some thorium and silicon possibly present as mechanical impurities.

It occurs in small monoclinic crystals (fig. 236) often flattened parallel to the orthopinacoid; also in disseminated grains or as sand and sometimes in angular masses. The luster is resinous and the color hyacinth-red, brown to yellow.

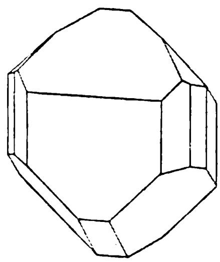


Fig. 236
Monazite

Monazite in the form of sand is quite abundant in certain parts of Brazil; it also occurs as a constituent of the gneiss rock of North Carolina and South Carolina.

It is the chief source of the thorium which is now extensively used in the manufacture of mantles for incandescent gas fixtures.

Apatite group

Apatite (phosphate rock) $Ca_5(Cl,F)(PO_4)_3$

Under this head are included the subdivisions fluor-apatite and chlor-apatite. The former is a calcium phosphate with calcium fluorid and the latter a calcium phosphate with calcium chlorid. Intermediate compounds contain both fluorin and chlorin in varying amounts.

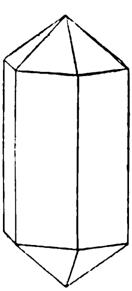


Fig. 237
Apatite

Apatite crystallizes in the pyramidal group of the hexagonal system. The crystals are prismatic in habit commonly terminated by the unit pyramid (fig. 237) and sometimes with the additional modification of the base; occasionally the prismatic crystals are short or tabular and show the modification of the third order pyramid (as in specimens from Knappenwand in the Tyrol). Compact massive varieties have a globular or reniform structure and are often found in rocklike

masses or nodules not unlike common limestone. The luster is vitreous to resinous and the color varies widely from sea-green, bluish green, brown or flesh-red, in the commoner occurrences, to transparent violet, yellow or colorless and opaque white or gray in the less common forms.

VARIETIES

Ordinary. Crystallized or granular massive material as described above.

Phosphorite. Fibrous concretionary and partly scaly masses.

Osteolite. Mostly altered and impure apatite of a compact earthly nature and white or gray in color.

RELATED

Phosphate rock. A massive impure phosphatic material chiefly of organic origin, and granular, spongelike or nodular in structure. Here are included the phosphatic limestones, guano deposits and bone beds from which is extracted material of considerable importance in the manufacture of fertilizers.

Apatite occurs in a great variety of formations but is most common in metamorphic crystalline rocks particularly in granular limestone, in gneiss, syenite, mica schist and in beds of iron ore. As an accessory rock mineral it has a wide distribution. It is found in many igneous rocks, the larger crystals being characteristic of granite and pegmatite, where it is associated with quartz, feldspar, tourmalin, muscovite, beryl, etc.

Besides many foreign localities apatite occurs in extensive deposits in the Laurentian gneiss of Canada associated with calcite, pyroxene, amphibole, titanite, etc. It is found in Maine, New Hampshire, Massachusetts, Connecticut, and in New York, in St Lawrence, Jefferson, Essex and Orange counties; also in Pennsylvania and North Carolina. Extensive deposits of phosphate rock occur in eastern South Carolina and Florida.

Apatite in the form of phosphate rock is largely used for fertilizers. The purer material is employed in the manufacture of phosphorus.

Pyromorphite (green lead ore) $(PbCl)Pb_4(PO_4)_3$

Pyromorphite is a phosphate of lead with lead chlorid, often with some arsenic, iron or calcium. With a larger proportion of arsenic it passes into mimetite.

1 Mimetite, Cornwall, England

2 Wavellite, Garland county, Ga.

It occurs in hexagonal crystals of the pyramidal group, prismatic in habit, often in rounded or barrel-shaped forms or in parallel and branching groups (pl. 36_2), less frequently in globular and reniform masses with a subcolumnar structure. The luster is resinous and the color usually some shade of green, yellow or brown, also grayish white or milk-white.

Pyromorphite occurs principally in veins with galena and other lead minerals. It is found in Saxony, Bohemia and Nassau and in several places in England and Scotland. In the United States it occurs in Maine, Pennsylvania, North Carolina and at Ossining N. Y.

Mimetite $(PlCl)Pb_4(AsO_4)_3$

Mimetite is an arsenate of lead with lead chlorid. With the replacement of arsenic by phosphorus it grades into pyromorphite; calcium also frequently replaces part of the lead.

The crystals of mimetite are hexagonal-pyramidal and resemble those of pyromorphite; they show, however, a marked tendency toward the production of rounded, globular aggregates (pl. 37_1). The mineral also occurs in mammillary crusts. The luster is resinous and the color yellow to brown or white. Its occurrence is similar to that of pyromorphite.

Vanadinite $(PbCl)Pb_4(VO_4)_3$

Vanadinite is a vanadinate of lead with lead chlorid. Phosphorus is also often present in small amounts; also arsenic, both of which replace some of the vanadium.

The crystals are like those of pyromorphite and mimetite, often with hollow or cavernous faces on the basal plane, and sometimes showing the modification of the third order pyramid (fig. 238). The luster is resinous and the color deep red, brown to yellow.

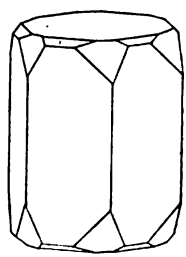


Fig. 238
Vanadinite

Vanadinite abounds in the mining regions of Arizona and New Mexico where it is associated with wulfenite.

Vanadinite is a source of vanadium salts, which are used in dyeing fabrics, and for the production of vanadium bronze, vanadium ink, etc.

Olivenite $Cu_2(OH)AsO_4$

Olivenite is a basic arsenate of copper. It occurs in small orthorhombic crystals of prismatic habit and often acicular; also in velvety or drusy masses of fibrous crystals and in globular forms. The luster is adamantine to vitreous and the color olive-green of various shades passing to brown and sometimes almost black, more rarely yellow or grayish white.

It is found in Cornwall, Devonshire, the Tyrol, the Ural mountains, Chile and in the Tintic district of Utah.

Libethenite $Cu_2(OH)PO_4$

Libethenite is a basic copper phosphate. It occurs in small orthorhombic crystals closely resembling those of olivenite in form and luster; the color is in general somewhat darker than that of olivenite.

Lazulite

Lazulite is a basic phosphate of aluminium, iron and magnesium.

It occurs in monoclinic crystals of pyramidal habit and in granular to compact masses. The luster is vitreous and the color deep sky-blue.

It occurs in veins in clay slate, quartzite, etc. and is found in Salzberg, Styria, Sweden and in North Carolina and Georgia.

Vivianite (blue iron earth) $Fe_3(PO_4)_2+8H_2O$

Vivianite is a hydrous phosphate of ferrous iron.

It occurs in monoclinic prismatic crystals, often in stellate groups; also as an earthy material replacing organic remains as bones, shells, etc. The luster is vitreous to dull. The unaltered material is colorless but gradually becomes blue or bluish green on exposure to air.

It occurs associated with pyrrhotite and pyrite in veins of copper or tin, in beds of clay or associated with limonite; also in cavities of fossils or buried bones.

Vivianite occurs in the United States in New Jersey, Virginia and Kentucky.

Erythrite (cobalt-bloom) $Co_3(AsO_4)_2+8H_2O$

Erythrite is a hydrous arsenate of cobalt.

It occurs in monoclinic prisms striated vertically and sometimes in stellate groups. Small globular and incrusting forms

with drusy or velvety surfaces are of frequent occurrence as well as an earthy variety pink in color. The luster is vitreous to adamantine, pearly on some faces, also dull or earthy. The color is crimson-red to peach-red.

It is found in Saxony, Baden, Norway and in the United States in Pennsylvania, Nevada and California.

Wavellite $Al_6(OH)_6(PO_4)_4+9H_2O$

Wavellite is a hydrous basic phosphate of aluminium.

Distinct orthorhombic crystals are rare. The mineral is commonly found in hemispheric or globular aggregates of radiating fibrous crystals (pl. 37_2). Stalactitic forms also occur. The luster is vitreous and the color white, yellow or green, occasionally brown, blue or black.

It is found in Devonshire, Saxony, Bohemia, Brazil and in Pennsylvania, Arkansas and North Carolina.

Turquoise $Al_2(OH)_3PO_4+H_2O$

Turquoise is a hydrous basic phosphate of aluminium with some copper, to which it owes its color.

It occurs in sky-blue to green nodules, veins or rolled masses with a dull or waxlike luster; also stalactitic or incrusting.

Turquoise occurs in porphyritic trachyte and in a clay slate which, in the Persian locality, is found penetrated by trachyte. It was formerly extensively mined in Persia; recently, however, important workings in New Mexico have been reopened and are producing very good material. Localities are also known in Arizona, California, Colorado and Nevada.

Turquoise is used as a gem.

Torbernite (copper uranite) $Cu(UO_2)_2P_2O_8+8H_2O$

Torbernite is a hydrous phosphate of uranium and copper.

It occurs in small tabular tetragonal crystals often extremely thin, of a bright green color and pearly luster. Less frequently it occurs in pyramidal forms or in foliated micaceous aggregates.

It has been found in Cornwall, Saxony and Bohemia.

Autunite (lime uranite) $Ca(UO_2)_2P_2O_8+8H_2O$

Autunite is a hydrous phosphate of uranium and calcium.

It is found in tabular orthorhombic crystals very similar to those of torbernite but lemon-yellow or sulfur-yellow in color.

It occurs in Connecticut, North Carolina and in the Black hills of South Dakota.

BORATES

Boracite $Mg_7Cl_2B_{16}O_{30}$

Boracite is a chloro-borate of magnesium.

The crystals are of the tetrahedral class of the isometric system and are commonly small and cubic (fig. 239), tetrahedral

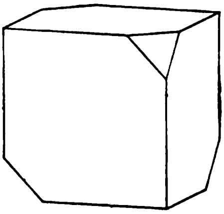


Fig. 239

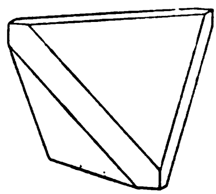


Fig. 240

Boracite

(fig. 240), octahedral or dodecahedral in habit; these usually occur isolated embedded in gypsum, anhydrite or salt. A massive variety occurs in snow-white, soft and powdery masses. The crystals are colorless, white to gray, yellow or green and vitreous to adamantine in luster.

Boracite is found associated with other minerals which have been deposited from solution and occurs in many parts of Europe notably at Stassfurt, Prussia.

Colemanite $Ca_2B_6O_{11}+5H_2O$

Colemanite is a hydrous borate of calcium often occurring in monoclinic crystals, short prismatic in habit, and somewhat resembling those of datolite, also in cleavable to granular and compact masses. Colemanite is commonly white or colorless and of a vitreous to dull luster.

Under this species are included:

Priceite. A massive variety, white and chalky in appearance and loosely compacted in structure.

Pandermite. A white variety in firm, compact, porcelainlike masses.

Colemanite is found quite abundantly in California, Nevada and Oregon. Pandermite is mined near Panderma in Turkey. Colemanite is an important source of the borax of commerce.

Borax (tinkal) $Na_2B_4O_7.10H_2O$

Borax is a hydrous borate of sodium.

It occurs in sharp, well formed monoclinic crystals transparent to opaque resembling those of pyroxene in habit. The color is white to gray sometimes inclining to greenish or bluish and the luster is vitreous to dull.

Borax is present in solution in many lakes of a saline or alkaline nature and is found crystallized in the mud at the bottom and in deposits in the surrounding marshes. Deposits of considerable importance occur in Nevada and California.

It is used in many industries such as soap, glass making etc., as a preservative and in washing, bleaching and antiseptic preparations.

Ulexite $NaCaB_5O_9.8H_2O$

Ulexite is a hydrated borate of sodium and calcium.

It occurs in loose rounded masses of fibrous crystals, white in color and with a silky luster.

Its occurrence is similar to colemanite and borax and it is found in Nova Scotia and Chile as well as in the borax localities of Nevada and California.

It is much used in the manufacture of borax.

URANATES

Uraninite (pitchblende)

Uraninite is a uranate of uranyl, lead, usually thorium (or zirconium) and frequently metals of the lanthanum and yttrium groups. The relation between the bases, however, varies so widely that no definite formula can be given.

It rarely occurs in isometric crystals of octahedral habit but is commonly found in botryoidal or granular masses pitchlike in luster and appearance and generally black in color.

Uraninite occurs as a primary constituent of granitic rocks and as a secondary mineral with silver, lead and copper ores. The main supply is obtained from Bohemia. It is mined, how-

ever, in Colorado and is found to some extent in North Carolina, South Carolina, Texas and in the Black hills of South Dakota.

It is the principal source of the uranium salts used in painting on porcelain and in the manufacture of fluorescent glass.

SULFATES, CHROMATES, ETC.

Barite (heavy spar, barytes) $BaSO_4$

Barite is the sulfate of barium, sometimes containing strontia, silica, clay, etc. as impurities.

It occurs in orthorhombic crystals which are often tabular in habit (fig. 241, 242); these are sometimes united in divergent

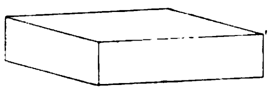


Fig. 241

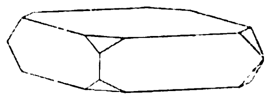


Fig. 242
Barite

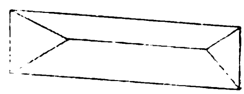


Fig. 243

groups giving the crested appearance shown in pl. 38_1, and passing by insensible gradations into straight or curved laminated masses. Crystals with prominent dome faces (fig. 243) are also frequent. Massive forms are of a granular, fibrous, earthy, stalactitic or nodular structure. Barite cleaves easily parallel to the basal and prismatic faces. The color is commonly white or light shades of yellow, brown, red or blue; the luster is vitreous to pearly.

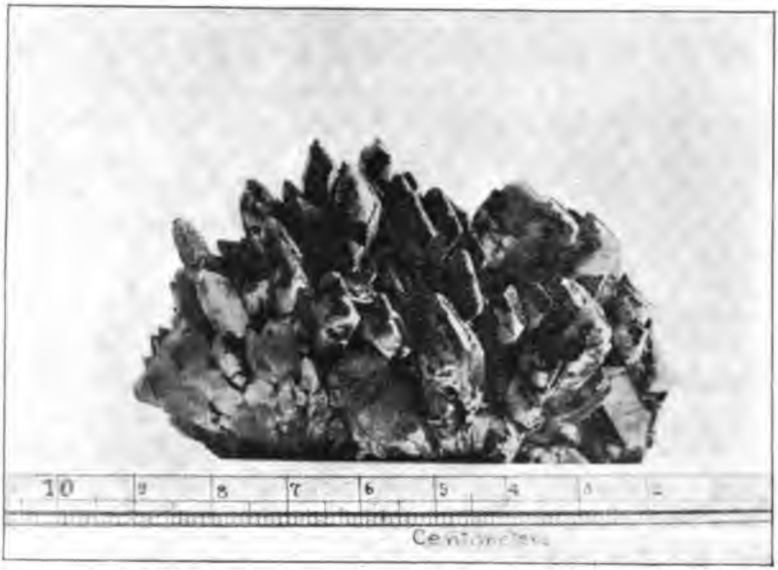
Barite frequently occurs associated with metallic deposits, particularly with lead, copper, iron, silver, manganese and cobalt. It is mined in North Carolina, Virginia and Missouri, and is also found in Connecticut, Tennessee, Kentucky, Illinois and in Jefferson and St Lawrence counties, of New York. It is also mined in Germany and Hungary.

White varieties of barite are ground and used as an adulterant of white lead and to give weight and body to paper and certain kinds of cloth. The colored varieties are sometimes polished for ornamental purposes.

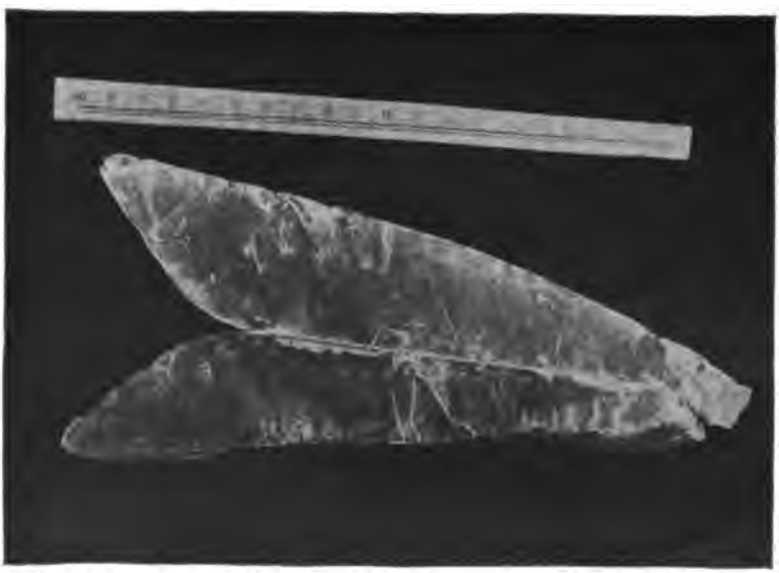
Anhydrite $CaSO_4$

Anhydrite is an anhydrous calcium sulfate.

It is rarely found in orthorhombic crystals; massive forms are often characterized by rectangular cleavage in three directions.



1 Barite, Hartz, Germany



2 Gypsum, Paris, France

Fibrous, granular and marblelike masses occur, sometimes exhibiting a sugarlike appearance on the fracture. The color is commonly white or gray, often bluish, reddish or brick-red. The luster is vitreous inclining to pearly.

Anhydrite occurs associated with rock salt, gypsum and limestones of various ages. It is found in New Brunswick and Nova Scotia and to a limited extent at Lockport N. Y. and in eastern Pennsylvania and Tennessee.

Anglesite $PbSO_4$

Anglesite is a sulfate of lead containing 26.4% sulfur trioxid and 73.6% lead oxid.

The crystals are orthorhombic and of varied habit. Massive forms are extremely common, the mineral frequently forming in concentric layers around a core of galena. Anglesite is white, gray or more rarely bluish or yellowish in color; the crystals are often transparent and colorless. The luster is adamantine to vitreous.

It is a frequent decomposition product of galena with which it is commonly associated and often alters to cerussite. It is found throughout the United States in the lead regions notably in Pennsylvania, Missouri, Wisconsin and Colorado. Extensive deposits occur in Mexico and Australia.

It is mined with other lead minerals as an ore of lead.

Celestite $SrSO_4$

Celestite is a sulfate of strontium sometimes containing small amounts of calcium and barium.

It crystallizes in the orthorhombic system in forms generally similar in type to those of barite, often tabular parallel to the base or prismatic to the macro or brachy axes (fig. 244). Fibrous massive forms occur with a parallel or radiated silky structure; also cleavable masses and more rarely granular varieties. In color celestite varies from white to pale blue, sometimes reddish; the crystals are often transparent and colorless. The luster is vitreous to pearly.

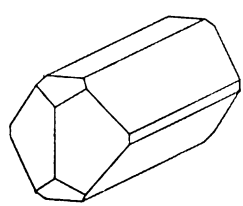


Fig. 244
Celestite

Celestite is of frequent occurrence in limestone and sandstone, in beds of gypsum, rock salt, etc.; and in volcanic regions asso-

ciated with sulfur and other eruptive minerals. Beautiful crystals have been obtained from Girgenti, Sicily. It also occurs at several localities on Lake Erie; at Lockport, Chaumont bay, Rossie and Schoharie N. Y.; in Pennsylvania, West Virginia, Tennessee, Kansas, Texas and California, and at Kingston Canada.

As a source of strontium nitrate, celestite is much used in the manufacture of fireworks.

Crocoite $PbCrO_4$

Crocoite is a lead chromate occurring in monoclinic crystals of prismatic habit and in imperfectly columnar and granular masses. It is of a bright hyacinth-red to orange-yellow color. The luster is adamantine.

Brochantite $4CuO.SO_3.3H_2O$

Brochantite is a basic sulfate of copper commonly found in acicular orthorhombic crystals or drusy crusts of an emerald-green or blackish green color and vitreous luster.

Gypsum (selenite, alabaster) $CaSO_4+2H_2O$

Gypsum is a hydrous calcium sulfate.

The crystals are monoclinic and commonly quite simple in form, fig. 245 and 246 representing types of common occurrence.

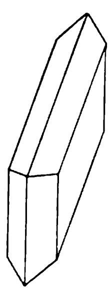


Fig. 245

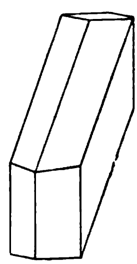


Fig. 246

Gypsum

Twins of the arrowhead form shown in pl. 38_2 are quite frequent. Massive forms have a foliated, lamellar or granular structure and a fibrous variety known as satin spar is often of marked beauty. Easy cleavage parallel to the clinopinacoid yields thin polished plates. The color varies from white to gray, flesh-red, yellow or light blue. The luster is pearly to subvitreous.

VARIETIES

Selenite. A colorless transparent variety usually in distinct crystals or broad folia.

Fibrous. A coarse or fine fibrous variety, translucent and silky in luster.

Alabaster. A compact, fine grained gypsum much used for carved objects.

Rock gypsum. An earthy dull colored variety often containing clay, calcium carbonate or silica as an impurity.

Extensive deposits of gypsum have resulted from the evaporation and concentration of ancient seas and landlocked waters. Gypsum is also produced by volcanic action and from the decomposition of limestone by sulfuric acid. In New York gypsum is found throughout the rocks of the Salina group in considerable quantities associated with halite. Deposits also occur in Ohio, Illinois, Virginia, Tennessee, Kansas and Arkansas and to a considerable extent in Nova Scotia.

Gypsum is burned and ground for plaster of paris and when ground from the raw material is of considerable value as a fertilizer. Alabaster and, to some extent, satin spar are used for carved ornamental objects.

Epsomite (epsom salt) $MgSO_4+7H_2O$

Epsomite is a hydrous magnesium sulfate. It is usually found in white botryoidal masses and delicately fibrous crusts and is characterized by its bitter saline taste.

Alunite (alum stone) $K(AlO)_3(SO_4)_2+3H_2O$

Alunite is a hydrous sulfate of aluminium and potassium.

It crystallizes in rhombohedrons closely resembling cubes. It also occurs in massive forms of fibrous, granular or impalpable structure. The color is generally white, often shading to grayish or reddish. The luster is vitreous to pearly.

It occurs as seams in rocks of a trachytic character where it has been formed by the action of sulfur dioxid and steam. It is found in Rosita hills, Col.

Alunite is used in the production of alum.

TUNGSTATES, MOLYBDATES

Wolframite (wolfram) $(Fe,Mn)WO_4$

Wolframite is a tungstate of iron and manganese in which these metals are present in varying amounts.

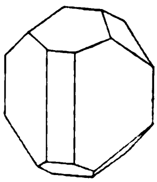


Fig. 247
Wolframite

The crystals are monoclinic, of the general type shown in fig. 247. These are commonly tabular parallel to the orthopinacoid; also prismatic. Twins are quite frequent; granular or columnar masses also occur. Perfect cleavage parallel to the clinopinacoid is characteristic as well as parting planes parallel to the orthopinacoid and hemiorthodome. The color is a dark grayish or brownish black and the luster is submetallic.

Wolframite occurs associated with tin ores and other metallic minerals notably in the Cornwall and German mines. It is also found in New South Wales and Bolivia and in Connecticut, North Carolina, Missouri and Dakota.

It is used in the manufacture of tungsten steel and as a source of the tungsten salts, which are of considerable importance in dyeing.

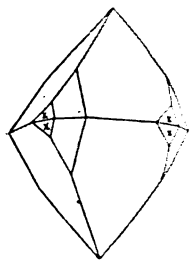


Fig. 248
Scheelite

Scheelite $CaWO_4$

Scheelite is a calcium tungstate crystallizing in the pyramidal class of the tetragonal system.

The crystals are pyramidal in habit (fig. 248), more rarely tabular. These often occur in drusy crusts. The color is white or light shades of yellow, brown, red, rarely green. The luster is vitreous tending to adamantine.

Scheelite occurs in crystalline rocks associated with cassiterite, fluorite, topaz, apatite, molybdenite or wolframite, incrusting or in quartz, and sometimes associated with gold. It is of comparatively rare occurrence but is found at Monroe and Trumbull Ct. and in South Carolina, Nevada, Idaho and Colorado.

Wulfenite $PbMoO_4$

Wulfenite is a lead molybdate crystallizing in the pyramidal class of the tetragonal system.

The crystals are commonly thin tabular in habit of the general type shown in fig. 249; octahedral or prismatic forms are much

less frequent, as are also granular massive forms. The commoner colors include a wax-yellow, orange to bright red and brown; an olive-green variety is rather rare.

Wulfenite occurs in veins associated with other ores of lead particularly vanadinite and pyromorphite. In the United States it is principally found in Arizona and New Mexico though smaller deposits have been found in Massachusetts, near Ossining N. Y., in Pennsylvania, Missouri, Wisconsin, Nevada, Utah and California.

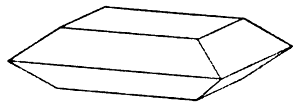


Fig. 249
Wulfenite

HYDROCARBON COMPOUNDS

With few exceptions, hydrocarbon compounds are not homogeneous substances and hence are not to be classed as definite mineral species. On the other hand, several substances belonging to this division have acquired so much importance from an economic point of view that it is thought best to briefly describe them here.

Amber

Amber occurs in irregular masses which break with a concoidal fracture. It has a resinous luster, is usually yellowish in color and is transparent to translucent. Amber is of vegetable origin and is derived from the fossilization of gums or resins, a fact which is frequently shown by the presence of insects in it.

It is found in Denmark and Sweden, on the Prussian coast of the Baltic and in Russian Baltic provinces. It is used for jewelry and for mouthpieces of pipes.

Petroleum

Members of this series grade from a thin yellow fluid to dark brown or nearly black viscid oils; the greenish brown colors are the most common. The density also varies and it may be generally stated that the light varieties are richest in volatile constituents while the heavier and darker kinds produce the benzins on distillation.

Petroleum is found in rocks of various ages from the Lower Silurian to the present epoch but is most abundant in argillaceous shales, sands and sandstones. Considerable petroleum is furnished by the regions of western Pennsylvania, southwestern New York and Ohio. It is also largely produced in the neighborhood of the Caspian sea and occurs in many other localities.

Asphaltum

Asphaltum or mineral pitch is an amorphous mixture of hydrocarbons, for the most part oxygenated. It is characterized by a black color and dull luster and melts at about 100° F.

Asphaltum is not associated with rocks of any particular age but is most abundant in formations containing bituminous material or vegetable remains. It is found in the region of the Dead sea; in Trinidad, where it forms a lake about a mile and a half in circuit; and in various places in South America and elsewhere. Its use for paving purposes is well known.

Uintaite (gilsonite). A variety of asphalt found in considerable deposits in Utah.

Albertite. An amorphous hydrocarbon compound differing from ordinary asphaltum in its very imperfect fusibility and in the fact that it is only partially soluble in oil of turpentine. It has a brilliant luster and is jet black in color. Albertite occurs in the rocks of the Lower Carboniferous in Nova Scotia.

Mineral coal

Coal is a compact massive substance consisting mainly of oxygenated hydrocarbons. It is black, grayish black or brownish black in color, occasionally iridescent, and has a luster varying from dull to brilliant.

Coal owes its origin to the gradual alteration of organic deposits, chiefly vegetable. It occurs in beds interstratified with shales, sandstones and conglomerates, sometimes forming distinct layers of varying thickness.

Anthracite. Anthracite or hard coal is characterized by a bright, often submetallic luster and is iron-black in color, frequently iridescent. It contains comparatively little volatile matter.

Anthracite beds occur in the formations east of the Allegheny range, which in Pennsylvania reach a thickness of 3300 feet.

Bituminous coal. Bituminous coal differs from the above chiefly in the higher percentage of volatile hydrocarbon oils contained in it. Bituminous coal may be classed as:

1 caking or coking coal
2 noncaking coal
3 cannel coal

1 Iron (meteorite), Schwarzenberg, Saxony

Brown coal or lignite. Brown coal contains more oxygen than bituminous coal, is compact or earthy and yields a brownish black powder.

For a more detailed discussion of the occurrence and geologic relations of coal deposits the reader is referred to New York state museum bulletin 19 or to some work on economic geology.

METEORITES

Considerable knowledge regarding the probable character of heavenly bodies other than the earth is furnished by the meteorites or fallen stars. These fragments from planetary space contain a number of minerals which are identical with terrestrial species, as well as several which have not, up to this time, been found on the earth.

They have been classified into three groups:

1 **Siderites.** Metallic masses composed principally of iron alloyed with nickel and some manganese and cobalt. Polished surfaces of siderites when etched with dilute nitric acid develop a series of intersecting lines or bands which are known as Widmanstätten figures (pl. 39_1).

2 **Siderolites.** Masses of a spongy, cellular character composed partly of iron and partly of stony material and frequently containing embedded grains of chrysolite.

3 **Aerolites.** Masses composed principally of stony material in the form of silicates including chrysolite, enstatite and minerals in the pyroxene group.

Meteorites are of universal distribution and can not be said to be characteristic of any locality.

APPENDIX

GLOSSARY OF CRYSTALLOGRAPHIC TERMS

Acicular. Needlelike in structure.

Arborescent. With a branching structure like a tree or plant.

Axes. Imaginary lines drawn within a crystal for the purpose of studying the relation of its planes.

Axial ratio. The relations between the lengths of axes which are not interchangeable as determined by the intercepts of a prominent pyramid face.

Basal plane or base. A plane which truncates the crystal parallel to the basal axes.

Biaxial crystals. A term used to include in an optical division crystals of the orthorhombic, monoclinic and triclinic systems.

Binary. Twofold.

Bladed structure. Composed of bundles of broad flat crystals resembling the blades of knives.

Botryoidal. Derived from a Greek word meaning a bunch of grapes.

Brachyaxis. The shorter of the two basal axes in the orthorhombic and triclinic systems. The term brachy is derived from a Greek word meaning short.

Brachydomes. Domes or horizontal prisms parallel to the brachyaxis.

Brachypinacoid. A pinacoidal plane parallel to the vertical and brachy axes.

Brachyprisms, brachypyramids. Crystal forms the planes of which are more nearly parallel to the brachyaxis then those of the form which determines the axial ratio. [*See* p. 32, fig. 124]

Capillary crystals. Extremely elongated individuals resembling hairs or threads.

Clinoaxis. The axis which in the monoclinic system is oblique to the plane of the other two but is perpendicular to one of the latter.

Clinodomes. Domes or horizontal prisms the faces of which are parallel to the clinoaxis.

Clinopinacoid. A pinacoid parallel to the vertical and clino axes.

Clinoprisms, clinopyramids. Crystal forms the faces of which are more parallel to the clinoaxis than the form which determines the axial ratio.

Columnar structure. Composed of aggregates of elongated crystals resembling columns.

Coralloidal. Branching and interlacing forms resembling coral.

Crystalline aggregate. An aggregate of imperfect crystals.

Cube. An isometric form bounded by six rectangular faces. In ideal crystals the faces are square.

Dendritic. *See* Arborescent.

Dihexagonal. Presenting in section, a 12 sided symmetric figure closely related to a hexagon. [*See* p. 26, fig. 98]

Diploids. Isometric forms bounded by 24 four sided faces. The diploid is so named from the fact that the faces are grouped in pairs.

Ditetragonal. Presenting in section an eight sided symmetric figure somewhat resembling an octagon but more closely related to a square.

Divergent. Composed of elongated crystalline individuals which diverge or radiate from a center.

Dodecahedron. An isometric form bounded by 12 (dodeca) rhombic faces.

Domes. Horizontal prisms which in the orthorhombic, monoclinic and triclinic systems are parallel to one basal axis. The term is derived from the Latin *domus*, a house, to describe their resemblance to a hip roof.

Drusy. Covered with extremely minute crystals producing a roughened surface.

Faces. The bounding surfaces of a crystal.

Fibrous. Composed of slender filaments or fibers.

First order. A term applied in the tetragonal and hexagonal systems to pyramids and prisms the faces of which intersect two basal axes with equal intercepts; any plane of the hexagonal forms is parallel to the third basal axis.

Foliated. Composed of layers of imperfectly formed crystals which may be separated from one another with ease; derived from the Latin *folio*, a leaf.

Geode. A hollow rounded fragment lined with crystals.

Granular structure. Composed of irregular particles or grains.

Habit of crystals. The general preponderance of certain forms in crystals of a given species and from a given locality.

Hemimorphic. Having a dissimilar development of crystal planes on the two extremities.

Hexagonal. Sixfold.

Hexakistetrahedrons. Tetrahedral forms of the isometric system bounded by 24 triangular faces arranged in four groups of six each.

Hexoctaherons. Forms of the normal group of the isometric system bounded by 48 triangular faces. The name derived from the Greek refers to the grouping of the faces in eight groups of six each.

Inclusions. Foreign matter of a solid, liquid or gaseous nature inclosed within the crystal.

Isometric. Presenting the highest degree of symmetry in which the three crystallographic axes are interchangeable. The term is derived from two Greek words meaning equal measure and refers to the ideal development in which the three axes are of equal length.

Isomorphic. Presenting the close chemical and crystallographic relations stated on p. 45.

Macroaxis. The longer of the two basal axes in the orthorhombic and triclinic systems. The term macro is derived from a Greek word meaning long.

Macrodome. A dome or horizontal prism parallel to the macroaxis.

Macropinacoid. A pinacoidal plane parallel to the vertical and the macro axis.

Macroprisms, macropyramids. Crystal forms, the planes of which are more nearly parallel to the macroaxis than those of the form which determines the axial ratio. [*See* p. 32, fig. 124]

Mammillary structure. Consisting of rounded prominences; the term is derived from the Latin *mamma*, meaning a female breast.

Micaceous structure. In thin leaves which may be separated from one another as typified in the mica group of minerals.

Octahedron. A crystal form bounded by eight equilateral, triangular faces; derived from a Greek word meaning eight.

Orthoaxis. The axis which, in the monoclinic system, is perpendicular to the plane of the other two.

Orthodomes. Domes or horizontal prisms parallel to the orthoaxis.

Orthopinacoid. A pinacoid parallel to the vertical and ortho axes.

Orthoprisms, orthopyramids. Crystal forms the faces of which are more parallel to the orthoaxis than the form which determines the axial ratio.

Orthorhombic. Presenting the symmetry of the orthorhombic system, referable to three uninterchangeable axes which are at right angles to one another. Orthorhombic crystals are characterized by binary symmetry in three directions.

Pinacoids. Crystal forms composed of planes parallel to two axes and corresponding in position to the faces of a cube; the term is derived from a Greek word meaning a board.

Plane. One of the bounding plane surfaces of a crystal; the term is extended to include the imaginary extension of this bounding surface to meet the axes.

Prisms. Crystal forms the planes of which intersect two basal axes and are parallel to a third. Domes as described above may be regarded as horizontal prisms.

Pseudohexagonal. Apparently hexagonal; many crystals *seem*, by reason of twinning, to be hexagonal though belonging to a system of lower symmetry.

Pseudoisometric. Apparently isometric; note above.

Pseudomorph. A substance having the form of one mineral and the composition of another; the term is derived from two Greek words meaning a false form.

Pyramids. Crystal forms the planes of which intersect all three axes. In the isometric system forms of this type are designated by special terms such as octahedron, trioctahedron, etc.

Pyritohedrons. Isometric forms so named from their common occurrence in the species pyrite.

Radiated structure. Consisting of crystalline individuals which radiate from a center.

Reniform. Kidney-shaped; from the Latin *renes*, a kidney.

Reticulated. Interlaced like a net; from the Latin *reticulum*, a net.

Rhombohedrons. Hexagonal forms of trigonal symmetry bounded by six rhombic faces.

Scalenohedrons. Crystal forms of the tetragonal and hexagonal systems bounded by scalene triangles and presenting in general a somewhat wedgelike shape.

Second order. A term applied, in the tetragonal and hexagonal systems, to pyramids and prisms the faces of which are related to those of the corresponding first order forms as shown on p.26, fig.98.

Sphenoids. Crystal forms of the tetragonal and orthorhombic systems bounded by four triangular faces and closely related by analogy to the isometric tetrahedron.

Stalactitic structure. Consisting of pendant columns or forms resembling icicles.

Stellated structure. Consisting of radiating individuals producing star-like forms.

Striated. Grooved or furrowed in parallel lines.

Striations. Parallel grooves or furrows on the surfaces of crystals.

Symmetry. The regularity in the recurrence of faces and angles of the same kind.

System. One of the six divisions based on symmetry into which all crystals are divided.

Tetragonal. Fourfold.

Tetrahedron. An isometric form bounded by four equilateral triangles; identical with the regular polyhedron of solid geometry.

Tetrahexahedrons. Isometric forms bounded by 24 isosceles triangles, the faces are grouped in six groups of four, each group corresponding to one face of a cube or hexahedron.

Third order. A term applied, in the tetragonal and hexagonal systems, to pyramids and prisms the faces of which are related to those of the corresponding first order forms as shown on p. 27, fig. 102.

Trapezohedrons. Crystal forms of the isometric, tetragonal and hexagonal systems bounded by trapezohedral faces.

Triclinic. Presenting the lowest degree of symmetry and referable to three inclined axes.

Trigonal. Threefold or triangular.

Trisoctahedrons. Isometric forms bounded by 24 triangular faces arranged in eight groups of three, each group corresponding to one of the faces of an octahedron.

Twin crystals. Intergrowths of like crystals of the same substance symmetrically disposed with respect to certain lines but not in parallel position.

Twinning plane. In twin crystals, an imaginary plane common to both individuals.

Uniaxial. A term used to include in an optical division crystals of the tetragonal and hexagonal systems.

Unit form. A prominent crystal form which is arbitrarily chosen from among those of a given species to determine the axial ratio.

Vicinal planes. Low prominences produced on some crystal faces by disturbances during the growth of the crystal or by other causes.

Widmanstätten lines. Lines of crystalline structure developed on the polished surfaces of meteorites by the action of corrosive agents.

LIST OF ELEMENTS

THEIR SYMBOLS AND ATOMIC WEIGHTS

Aluminium	Al	27	Bromin	Br	79.8
Antimony	Sb	120	Cadmium	Cd	111.7
Argon	A	40	**Calcium**	Ca	39.9
Arsenic	As	74.9	**Carbon**	C	12
Barium	Ba	137	Cerium	Ce	140
Beryllium	Be	9.1	Cesium	Cs	132.7
Bismuth	Bi	207.5	**Chlorin**	Cl	35.5
Boron	B	11	Chromium	Cr	52.5

Cobalt	Co	58.7
Columbium, *see* Niobium		
Copper	Cu	63.2
Didymium	Di	142
Erbium	Er	166
Fluorin	F	19.1
Gadolinium	Gd	156
Gallium	Ga	69.9
Germanium	Ge	72.3
Glucinum, *see* Beryllium		
Gold	Au	196.7
Helium	He	4.3
Hydrogen	H	1
Indium	In	113.4
Iodin	I	126.5
Iridium	Ir	192.5
Iron	Fe	55.9
Lanthanum	La	138
Lead	Pb	206.4
Lithium	Li	7
Magnesium	Mg	24
Manganese	Mn	54.8
Mercury	Hg	199.8
Molybdenum	Mo	96
Neodymium	Nd	143.6
Nickel	Ni	58.6
Niobium	Nb	93.7
Nitrogen	N	14
Osmium	Os	191
Oxygen	O	16
Palladium	Pd	106.2
Phosphorus	P	31
Platinum	Pl	194.3
Potassium	K	39
Praseodymium	Pr	140.5
Rhodium	Rh	104.1
Rubidium	Rb	85.2
Ruthenium	Ru	103.5
Samarium	Sm	150
Scandium	Sc	44
Selenium	Se	78.9
Silicon	Si	28
Silver	Ag	107.7
Sodium	Na	23
Strontium	Sr	87.3
Sulfur	S	32
Tantalum	Ta	182
Terbium	Tb	160
Tellurium	Te	125
Thallium	Tl	203.7
Thorium	Th	232
Thulium	Tu	170
Tin	Sn	118
Titanium	Ti	48
Tungsten	W	183.6
Uranium	U	240
Vanadium	V	51.1
Ytterbium	Yb	172.6
Yttrium	Yt	89
Zinc	Zn	65.1
Zirconium	Zr	90.4

THE MINERAL COLLECTION OF THE NEW YORK STATE MUSEUM

Probably no mineral collection, however large and comprehensive in a comparative sense, can be regarded as exhaustive or complete. New minerals are constantly being discovered and new occurrences of known minerals constantly noted, so that as in the collections of every other department of science, a mineral collection is bound to increase to keep pace with the progress of discovery.

The mineralogic student should not lose sight of the fact that though comparatively few of the many hundreds of mineral species known to science are found in sufficient abundance to be of importance in the arts, the discovery of a considerable deposit of a species which is at present considered rare may at any time

raise it to a high rank in commercial importance. A notable instance of the latter case is afforded by the group of gold and silver tellurids developed within the last 10 years at Cripple Creek, Col. Prior to 1892 these minerals were classed among the rare species and were considered valuable only as mineral specimens.

The principal mineral collection of the New York state museum is displayed in vertical cases which line the walls of the mineral section beginning to the left of the entrance to the section. In arrangement the collection follows the order of this guide which is that of J. D. Dana's *System of mineralogy*. The disposition of the principal divisions is as follows:

DIVISION	CASE
Native elements	1
Sulfids, selenids, tellurids etc.	2
Sulfo salts Haloids	3
Oxids	4–8
Carbonates	9–13
Silicates	14–22
Titanates Niobates, tantalates	23
Phosphates, arsenates, vanadates etc.	24
Borates, uranates Sulfates	25
Tungstates, Molybdates Hydrocarbon compounds	26

In disposing the specimens in the cases the top and bottom shelves of each case are reserved for the display of large specimens representing the species of the divisions and groups installed in the case and the five intermediate shelves for the smaller specimens arranged in consecutive order. The swinging card catalogue installed in the spaces between the cases is practically exhaustive, the species represented in the cases being indicated by the letter w (wall cases) and the number which in every instance precedes the species name corresponding to a number placed in the upper left corner of the specimen label; these numbers also correspond to the numbered species of Dana's *System of mineralogy* cited above.

In every instance the most characteristic specimens under each species are to be found in the front row and are therefore best available for detailed study; the back row contains duplicates, massive specimens, and in general, material requiring less close examination. In most instances where the crystallization is of interest and importance wooden models are placed at the head of the species; these are followed by the best examples of crystallization available, crystalline masses and massive forms following the order given in the descriptive text.

An introductory collection illustrating the text of part 1 of this guide is displayed in the table cases of the southern half of the mineralogic section.

The student is also referred to a collection of minerals of economic importance at present displayed in the table cases of the northern half of the mineralogic section. The material here displayed is grouped under the following divisions:

Metalliferous division

A Metalliferous ores
- 1 Arsenic antimony and bismuth minerals
- 2 Gold minerals
- 3 Silver minerals
- 4 Mercury minerals
- 5 Copper minerals
- 6 Lead minerals
- 7 Zinc and cadmium minerals
- 8 Tin minerals
- 9 Nickel minerals
- 10 Uranium and chromium minerals
- 11 Iron minerals
- 12 Manganese minerals
- 13 Aluminium minerals

Nonmetalliferous division

B Substances used for chemical purposes
- 1 Sulfur, sulfuric and hydrofluoric acids

Nonmetalliferous division *(cont'd)*
- 2 Salt, potash, soda, borax and alum
- 3 Magnesium, strontium, titanium and thorium compounds
- 4 Plaster of paris
- 5 Substances used in the manufacture of chemical compounds

C Ceramic materials
- 1 Porcelain, earthenwares and bricks
- 2 Pottery and glassware

D Refractory materials
- 1 Graphite
- 2 Asbestos
- 3 Mica

E Materials of physical application
- 1 Abrasives
- 2 Graphic materials
- 3 Pigments
- 4 Fertilizers

BIBLIOGRAPHY[1]

For more detailed and exhaustive information on the subject of mineralogy the reader is referred to the following books:

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Burnham. Precious stones. 1886.
Dana, E. S. Minerals and how to study them. 1895.
——— Text book of mineralogy. 1898.
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——— Manual of mineralogy and petrography. 1896.
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Merrill, G. P. Guide to the study of the collections in the section of applied geology; Smithsonian institution. 1900. 1901.
Moses & Parsons. Mineralogy, crystallography and blowpipe analysis. 1900.
Williams, G. H. Elements of crystallography. 1891.
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[1]This list is confined to works in English and could be materially added to should the student wish to consult French and German publications.

GENERAL INDEX

INDEX TO MINERAL SPECIES

University of the State of New York

New York State Museum

MUSEUM PUBLICATIONS

Any of the University publications will be sold in lots of 10 or more at 20% discount. When sale copies are exhausted, the price for the few reserve copies is advanced to that charged by secondhand booksellers to limit their distribution to cases of special need. Such prices are inclosed in brackets.

All publications are in paper covers, unless binding is specified.

Museum annual reports 1847–date. *All in print to 1892, 50c a volume, 75c in cloth; 1892–date, 75c, cloth.*

These reports are made up of the reports of the director, geologist, paleontologist, botanist and entomologist, and museum bulletins and memoirs, issued as advance sections of the reports.

Geologist's annual reports 1881–date. Rep'ts 1, 3-13, 17–date, O.; 2, 14–16, Q.

The annual reports of the early natural history survey, 1836-42 are out of print.

Reports 1-4, 1881-84 were published only in separate form. Of the 5th report 4 pages were reprinted in the 39th museum report, and a supplement to the 6th report was included in the 40th museum report. The 7th and subsequent reports are included in the 41st and following museum reports, except that certain lithographic plates in the 11th report (1891), 13th (1893) are omitted from the 45th and 47th museum reports.

Separate volumes of the following only are available.

Report	*Price*	*Report*	*Price*	*Report*	*Price*
12 (1892)	$.50	16	$1	19	$.40
14	.75	17	.75	20	.50
15	1	18	.75		

In 1898 the paleontologic work of the State was made distinct from the geologic and will hereafter be reported separately.

Paleontologist's annual reports 1899–date.

See fourth note under Geologist's annual reports.

Bound also with museum reports of which they form a part. Reports for 1899 and 1900 may be had for 20c each. Beginning with 1901 these reports will be issued as bulletins.

Botanist's annual reports 1869–date.

Bound also with museum reports 22–date of which they form a part; the first botanist's report appeared in the 22d museum report and is numbered 22.

Reports 22-41, 48, 49, 50 and 52 (Museum bulletin 25) are out of print; 42-47 are inaccessible. Report 51 may be had for 40c; 53 for 20c; 54 for 50c. Beginning with 1901 these reports will be issued as bulletins.

Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have been published in volumes 1 and 3 of the 48th museum report and in volume 1 of the 49th, 51st and 52d reports. The botanical part of the 51st is available also in separate form. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged, and combined with others more recently prepared and constitute Museum memoir 4.

Entomologist's annual reports on the injurious and other insects of the State of New York 1882–date.

Bound also with museum reports of which they form a part. Beginning with 1898 these reports have been issued as bulletins. Reports 3-4 are out of print, other reports with prices are:

Report	*Price*	*Report*	*Price*	*Report*	*Price*
1	$.50	8	$.25	13	$.10
2	.30	9	.25	14 (Mus. bul. 23)	.20
5	.25	10	.35	15 (" 31)	.15
6	.15	11	.25	16 (" 36)	.25
7	.20	12	.25	17 (" 53)	.30

Reports 2, 8 – may also be obtained bound separately in cloth at 25c in addition to the price given above.

Museum bulletins 1887–date. O. *To advance subscribers, $2 a year or 50c a year for those of any one division: (1) geology, including economic geology, general zoology, archeology and mineralogy, (2) paleontology, (3) botany, (4) entomology.*

Bulletins are also found with the annual reports of the museum as follows:

Bulletins	*Report*	*Bulletins*	*Report*	*Bulletins*	*Report*
12–15	48, v. 1	20–25	52, v. 1	35–36	54, v. 2
16–17	50 "	26–31	53 "	37–44	" v. 3
18–19	51 "	32–34	54 "	45–48	" v. 4

The letter and figure in parenthesis after the bulletin number indicate the division and series number. G=geology, EG=economic geology, Z=general zoology, A=archeology, M=mineralogy, P=paleontology, B=botany, E=entomology, Misc=miscellaneous.

Volume 1. 6 *nos.* $1.50 *in cloth*

1 (Z1) Marshall, W: B. Preliminary List of New York Unionidae. 20p. Mar. 1892. *5c.*

2 (B1) Peck, C: H. Contributions to the Botany of the State of New York. 66p. 2pl. May 1887. [*35c*]

3 (EG1) Smock, J: C. Building Stone in the State of New York. 152p. Mar. 1888. *Out of print.*

4 (M1) Nason, F. L. Some New York Minerals and their Localities. 20p. 1pl. Aug. 1888. *5c.*

5 (E1) Lintner, J. A. White Grub of the May Beetle. 32p. il. Nov. 1888. *10c.*

6 (E2) ——— Cut-worms. 36p. il. Nov. 1888. *10c.*

Volume 2. 4 *nos.* [$1.50] *in cloth*

7 (EG2) Smock, J: C. First Report on the Iron Mines and Iron Ore Districts in New York. 6+70p. map. June 1889. *Out of print.*

8 (B2) Peck, C: H. Boleti of the United States. 96p. Sep. 1889. [*50c*]

9 (Z2) Marshall, W: B. Beaks of Unionidae Inhabiting the Vicinity of Albany, N. Y. 24p. 1pl. Aug. 1890. *10c.*

10 (EG3) Smock, J: C. Building Stone in New York. 210p. map. tab. Sep. 1890. *40c.*

Volume 3. 5 *nos.*

11 (EG4) Merrill, F: J. H. Salt and Gypsum Industries in New York. 92p. 12pl. 2 maps, 11 tab. Ap. 1893. *40c.*

12 (EG5) Ries, Heinrich. Clay Industries of New York. 174p. 2pl. map. Mar. 1895. *30c.*

13 (E3) Lintner, J. A. Some Destructive Insects of New York State; San José Scale. 54p. 7pl. Ap. 1895. *15c.*

14 (G1) Kemp, J. F. Geology of Moriah and Westport Townships Essex Co. N. Y., with notes on the iron mines. 38p. 7pl. 2 maps Sep. 1895. *10c.*

15 (EG6) Merrill, F: J. H. Mineral Resources of New York. 224p. 2 maps. Sep. 1895. *40c.*

Volume 4

16 (A1) Beauchamp, W: M. Aboriginal Chipped Stone Implements of New York. 86p. 23pl. Oct. 1897. *25c.*

17 (EG7) Merrill, F: J. H. Road Materials and Road Building in New York. 52p. 14pl. 2 maps 34x45, 68x92cm. Oct. 1897. *15c.*
Maps separate *10c each, two for 15c.*

18 (A2) Beauchamp, W: M. Polished Stone Articles used by the New York Aborigines. 104p. 35pl. Nov. 1897. *25c.*

19 (G2) Merrill, F: J. H. Guide to the Study of the Geological Collections of the New York State Museum. 162p. 119pl. map. Nov. 1898. *40c.*

Volume 5

20 (E4) Felt, E. P. Elm-leaf Beetle in New York State. 46p. il. 5pl. June 1898. *5c.*

21 (G3) Kemp, J. F. Geology of the Lake Placid Region. 24p. 1pl. map. Sep. 1898. *5c.*

22 (A3) Beauchamp, W: M. Earthenware of the New York Aborigines. 78p. 33pl. Oct. 1898. *25c.*

23 (E5) Felt, E. P. 14th Report of the State Entomologist 1898. 150p. il. 9pl. Dec. 1898. *20c.*

24 (E6) —— Memorial of the Life and Entomologic Work of J. A. Lintner Ph.D. State Entomologist 1874–98; Index to Entomologist's Reports 1–13. 316p. 1pl. Oct. 1899. *35c.*

Supplement to 14th report of the State entomologist.

25 (B3) Peck, C: H. Report of the State Botanist 1898. 76p. 5pl. Oct. 1899. *Out of print.*

Volume 6

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27 (E8) —— Shade-tree Pests in New York State. 26p. il. 5pl. May 1899. *5c.*

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30 (EG8) Orton, Edward. Petroleum and Natural Gas in New York. 136p. il. 3 maps. Nov. 1899. *15c.*

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32 (A4) Beauchamp, W: M. Aboriginal Occupation of New York. 190p. 16pl. 2 maps. Mar. 1900. *30c.*

33 (Z4) Farr, M. S. Check List of New York Birds. 224p. Ap. 1900. *25c.*

34 (P1) Cumings, E. R. Lower Silurian System of Eastern Montgomery County; Prosser, C: S. Notes on the Stratigraphy of Mohawk Valley and Saratoga County, N. Y. 74p. 10pl. map. May 1900. *15c.*

35 (EG9) Ries, Heinrich. Clays of New York: their Properties and Uses. 456p. 140pl. map. June 1900. *$1, cloth.*

36 (E10) Felt, E. P. 16th Report of the State Entomologist 1900. 118p. 16pl. Mar. 1901. *25c.*

Volume 8

37 (E11) —— Catalogue of Some of the More Important Injurious and Beneficial Insects of New York State. 54p. il. Sep. 1900. *10c.*

38 (Z5) Miller, G. S. jr. Key to the Land Mammals of Northeastern North America. 106p. Oct. 1900. *15c.*

39 (P2) Clarke, J: M.; Simpson, G: B. & Loomis, F: B. Paleontologic Papers 1. 72p. il. 16pl. Oct. 1900. *15c.*

Contents: Clarke, J: M. A Remarkable Occurrence of Orthoceras in the Oneonta Beds of the Chenango Valley, N. Y.

—— Paropsonema Cryptophya; a Peculiar Echinoderm from the Intumescens-zone (Portage Beds) of Western New York.

—— Dictyonine Hexactinellid Sponges from the Upper Devonic of New York.

—— The Water Biscuit of Squaw Island, Canandaigua Lake, N. Y.

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40 (Z6) Simpson, G: B. Anatomy and Physiology of Polygyra Albolabris and Limax Maximus and Embryology of Limax Maximus. 82p. 28pl. Oct. 1901. *25c.*

41 (A5) Beauchamp, W: M. Wampum and Shell Articles used by New York Indians. 166p. 28pl. Mar. 1901. *30c.*

42 (P3) Ruedemann, Rudolf. Hudson River Beds near Albany and their Taxonomic Equivalents. 114p. 2pl. map. Ap. 1901. *25c.*

43 (Z7) Kellogg, J. L. Clam and Scallop Industries of New York. 36p. 2pl. map. Ap. 1901. *10c.*

44 (EG10) Ries, Heinrich. Lime and Cement Industries of New York; Eckel, E. C. Chapters on the Cement Industry. *In press.*

Volume 9

45 (P4) Grabau, A. W. Geology and Paleontology of Niagara Falls and Vicinity. 286p. il. 18pl. map. Ap. 1901. *65c; cloth 90c.*

46 (E12) Felt, E. P. Scale Insects of Importance and a List of the Species in New York. 94p. il. 15pl. June 1901. *25c.*

47 (E13) Needham, J. G. & Betten, Cornelius. Aquatic Insects in the Adirondacks. 234p. il. 36pl. Sep. 1901. *40c.*

48 (G4) Woodworth, J. B Pleistocene Geology of Nassau County and Borough of Queens. 58p. il. 9pl. map. Dec. 1901. *25c.*

Volume 10

49 (P5) Ruedemann, Rudolf; Clarke, J: M. & Wood, Elvira. Paleontologic Papers 2. 240p. 13pl. Dec. 1901. *40c.*

Contents: Ruedemann, Rudolf. Trenton Conglomerate of Rysedorph Hill.
Clarke, J: M. Limestones of Central and Western New York Interbedded with Bituminous Shales of the Marcellus Stage.
Wood, Elvira. Marcellus Limestones of Lancaster, Erie Co. N. Y.
Clarke, J: M. New Agelacrinites.
—— Value of Amnigenia as an Indicator of Fresh-water Deposits during the Devonic of New York, Ireland and the Rhineland.

50 (A6) Beauchamp, W: M. Horn and Bone Implements of the New York Indians. 112p. 43pl. Mar. 1902. *30c.*

51 (Z8) Eckel, E. C. & Paulmier, F. C. Catalogue of Reptiles and Batrachians of New York. 64p. il. 1pl. Ap. 1902. *15c.*

Eckel, E. C. Serpents of Northeastern United States.
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52 (P6) Clarke, J: M. Report of the State Paleontologist 1901. 280p. 9pl. map. 1 tab. il. July 1902. *40c.*

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58 (M2) Whitlock, H. P. Guide to the Mineralogic Collections of the New York State Museum. 150p. il. 39 pl. 11 models. Sep. 1902. *40c.*

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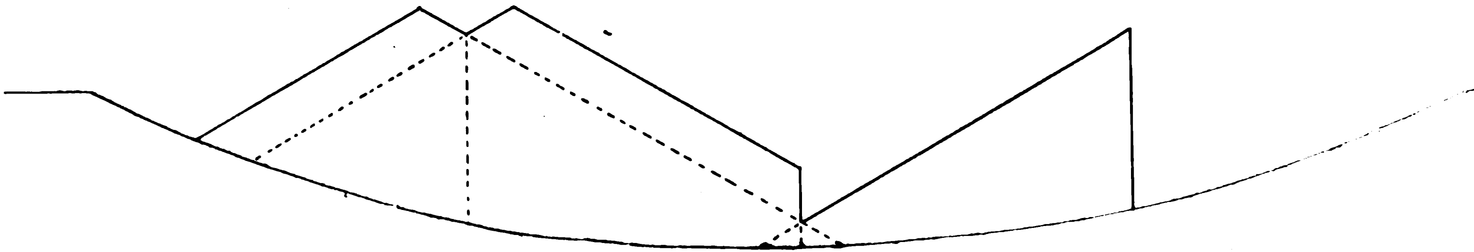

Crystal models

In folding these models, hold the edge of a ruler or paper-cutter firmly on the dotted line and crease the cardboard well over by means of the finger nail or the back of a penknife. In pasting the model together begin by joining those faces which form a continuous series, as for instance the four connected faces of model 2.

MUSEUM PUBLICATIONS (*concluded*)

Museum memoirs 1889–date. Q.

1 Beecher, C: E. & Clarke, J: M. Development of some Silurian Brachiopoda. 96p. 8pl. Oct. 1889. *Out of print.*

2 Hall, James & Clarke, J: M. Paleozoic Reticulate Sponges. 350p. il. 70pl. Oct. 1899. *$1, cloth.*

3 Clarke, J: M. The Oriskany Fauna of Becraft Mountain, Columbia Co. N. Y. 128p. 9pl. Oct. 1900. *80c.*

4 Peck, C: H. N. Y. Edible Fungi, 1895–99. 106p. 25pl. Nov. 1900. *75c.*
This includes revised descriptions and illustrations of fungi reported in the 49th, 51st and 52d reports of the state botanist.

5 Clarke, J: M. & Ruedemann, Rudolf. The Guelph Formation and Fauna of New York State. *In preparation.*

6 Clarke, J: M. The Naples Fauna in Western New York. *In preparation.*

Natural history of New York. 30v. il. pl. maps. Q. Albany 1842–94.

DIVISION 1 ZOOLOGY. De Kay, James E. Zoology of New York; or, The New York Fauna; comprising detailed descriptions of all the animals hitherto observed within the State of New York with brief notices of those occasionally found near its borders, and accompanied by appropriate illustrations. 5v. il. pl. maps. sq. Q. Albany 1842–44. *Out of print.*
Historical introduction to the series by Gov. W: H. Seward. 178p.

DIVISION 2 BOTANY. Torrey, John. Flora of the State of New York; comprising full descriptions of all the indigenous and naturalized plants hitherto discovered in the State, with remarks on their economical and medical properties. 2v. il. pl. sq. Q. Albany 1843. *Out of print.*

DIVISION 3 MINERALOGY. Beck, Lewis C. Mineralogy of New York; comprising detailed descriptions of the minerals hitherto found in the State of New York, and notices of their uses in the arts and agriculture. il. pl. sq. Q. Albany 1842. *Out of print.*

DIVISION 4 GEOLOGY. Mather, W: W.; Emmons, Ebenezer; Vanuxem, Lardner & Hall, James. Geology of New York. 4v. il. pl. sq. Q. Albany 1842–43. *Out of print.*

DIVISION 5 AGRICULTURE. Emmons, Ebenezer. Agriculture of New York; comprising an account of the classification, composition and distribution of the soils and rocks and the natural waters of the different geological formations, together with a condensed view of the meteorology and agricultural productions of the State. 5v il. pl. sq. Q. Albany 1846–54. *Out of print.*

DIVISION 6 PALEONTOLOGY. Hall, James. Paleontology of New York. 8v. il. pl. sq. Q. Albany 1847–94. *Bound in cloth.*

Museum handbooks 1893–date. 7½x12½ cm.
In quantities, 1 cent for each 16 pages or less. Single copies postpaid as below.

H5 New York State Museum. 14p. il. *3c.*
Outlines history and work of the museum; with list of staff and scientific publications, 1893.

H13 Paleontology. 8p. *2c.*
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EPHRAIM PORTER FELT State Entomologist

Bulletin 59

ENTOMOLOGY 16

GRAPEVINE ROOT WORM

BY

EPHRAIM PORTER FELT D.Sc.

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New York State Museum

FREDERICK J. H. MERRILL Director
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ENTOMOLOGY 16

GRAPEVINE ROOT WORM

PREFACE

The grapevine root worm has proved itself such a destructive enemy of vineyards in the Chautauqua grape belt and so little has been done to control it, that it was deemed advisable last spring to undertake an investigation of this insect, particularly as the entomologist's aid had been solicited on several occasions. This bulletin is issued at the present time not that the investigations are complete, but because the subject is of such vital importance that our growers should have all available information at their disposal. Some valuable facts have been ascertained during the past season and it is hoped that future investigations may result in demonstrating some satisfactory method of controlling this very serious enemy of the vineyardist.

Through the courtesy of the Hon. C. A. Wieting, commissioner of agriculture, the entomologist has been able to avail himself of the services of Mr J. Jay Barden, a San José scale inspector in the western section of the State. Mr Barden has cooperated with the writer very efficiently and most of the field investigations were carried on with the assistance of this gentleman. The breeding cage and other office experiments have been conducted under the writer's direction by his first assistant Mr C. M. Walker aided by the second assistant Mr D. B. Young. The author is also under obligations to Prof. Percy J. Parrott, entomologist of the Ohio Agricultural Experiment Station, and

Prof. A. F. Burgess, chief San José scale inspector of Ohio, who kindly accompanied him in his investigation of conditions in that state.

E. P. Felt

Albany N. Y. September 1902

GRAPEVINE ROOT WORM

Fidia viticida Walsh

Ord. *Coleoptera:* Fam. *Chrysomelidae*

INTRODUCTION

The vineyardists in the Chautauqua grape belt are confronted by a serious condition in the presence of the above named insect. This pest has in recent years caused enormous damages in the Ohio grape belt and is now established in large numbers in the vicinity of Ripley N. Y. and has obtained a foothold over a large area. Messrs Walter Northrop and F. A. Morehouse estimated last spring that over 80 acres of magnificent vineyards had already been destroyed in the vicinity of Ripley. We consider this insect a much more serious enemy of the vineyardist than the grapevine leaf hopper, the work of which has been so apparent and destructive in the last two or three years. The leaf hopper undoubtedly causes much mischief, but as its operations are confined to the leaves, the amount of damage is easily seen and, when necessary, steps may be taken to control the pest. The root worm, on the other hand, inflicts its most serious injuries under ground where its operations can not be readily observed, and in a great many instances a vine is nearly ruined before the grower notices any trouble. The secrecy of this insect's work and the fact that the grubs operate on the large roots, where a small amount of girdling is fatal, constitute the most dangerous features of this pest.

The vineyardists of the Chautauqua grape belt should be thankful for the very wet season just past, because it has undoubtedly enabled the vines to recuperate to a considerable extent from previous injuries and has also prevented serious damage by the root worms in 1902.

Area infested. Ripley appears to be the center of this insect's most destructive work, though it has been found generally present in small numbers in many vineyards where little evi-

dence of serious injury occurs. The pest very probably made its way into the Chautauqua grape belt from Ohio and is present in greater or less numbers as far east as Fredonia, if not farther. It has not been met with by us in numbers in other grape-growing sections.

Signs of the insect's presence. The more destructive work of this pest is somewhat difficult to detect, but indications of the presence of the beetles are so characteristic that there should be little trouble in locating them. The peculiar chainlike areas, represented on plates 5 and 1, figure 2, are very characteristic of the insect and differ so much from the work of most other pests that no difficulty should be experienced in identifying it. The beetles exhibit a decided preference for smaller vines, and the general appearance of some very badly eaten ones is shown on plate 4. The feeding of the beetle is usually the first visible indication of its presence and is rarely accompanied at the outset by signs of material injury. As the attack progresses and the work on the roots becomes more injurious, the development of the fruit is severely checked and the bunches may be less than half their normal size. The growth of wood is also much reduced and vines which are very badly infested may die in midsummer. Cases were brought to the writer's attention where plants which had grown over 6 feet of wood the preceding summer, wilted in June and died. Infested vines as a general thing become less thrifty, develop less and less wood yearly till finally there is not enough to tie up. A portion of a vineyard very seriously injured and where there is not wood enough to tie up is represented on plate 2. This condition rapidly becomes worse and soon the vines are simply a small mass of foliage resting on an old stump as represented on plate 3.

The depredations of this pest are much worse and usually first apparent on light sandy or poor soils, and in particular on gravelly knolls. The insects seem to thrive under such conditions and a deficient growth should lead to immediate investigation. Vines on rich clay soils, in our experience, sustain comparatively little injury from this pest and this appears to be the case in Ohio.

The condition of the roots also affords a clue to the identity of the depredator. The young grubs eat away the small feeding roots while the larger individuals gnaw the bark, particularly from the under side of the larger roots. They frequently eat away long strips, as represented on plate 1, figure 5, though occasionally a single grub may pursue a somewhat sinuous path.

A native species. This serious pest of the vineyards is not, like many of the forms so injurious to agriculturists, an imported insect. It has long been known to occur in this country and its work on wild grapevines was observed before its depredations attracted notice in our vineyards. This insect may develop into a general pest of the grape and perhaps in time come to be as well known as the very destructive Colorado potato beetle, which is familiar to almost every farmer. It is very probable that this grape enemy was able to exist only in relatively small numbers on wild vines and hence was rarely very injurious. It seems to have developed a great fondness for some of our cultivated varieties and the growing of these in large areas has enabled it to increase to an almost unparalleled degree. This may perhaps be cited as one of the cases where the devotion of extensive tracts to one crop has resulted in a species formerly harmless becoming very destructive.

It is interesting to note in this connection that the species is by no means new to New York State. There are examples of the beetles in the private collection of the late J. A. Lintner, which were taken in Schenectady in 1880 and on Virginia creeper at Albany in 1882, and yet so far as known there is no record of the species proving destructive in this section. The writer also met with the insect at Albany in considerable numbers on Virginia creeper in 1901, and though he has frequently visited vineyards in the vicinity, no signs of the insect were observed. It is very possible that the death of vines in early years here and there may have been caused by this beetle and attributed by the growers to other causes, as was the case before Professor Webster discovered the identity of the depredator in Ohio.

Allies. This species belongs to the family of leaf eating beetles, known as the Chrysomelidae, a group which comprises some of our most serious insect enemies. To it belongs the notorious elm leaf beetle, Galerucella luteola Müll., a species which has destroyed thousands of magnificent shade trees in the Hudson river valley. The two asparagus beetles, Crioceris asparagi Linn. and C. 12-punctata Linn., are well known enemies to the grower of this succulent vegetable. The familiar yellow and black striped squash bug, Diabrotica vittata Fabr. is another ally of this destructive grape pest, which is sometimes aided in its deadly work by the steely blue or grapevine flea beetle, Haltica chalybea Illg., a species which has caused great injury in some New York vineyards during recent years. A number of other related forms nearly as injurious as those named could be easily listed. These destructive allies are mentioned in this connection simply that the grape grower may have some idea of what related species can do, and while this pest may not prove so destructive as any of these, it has already demonstrated its ability to cause much mischief. We see no reason at present for thinking that the history of this insect in Ohio may not be duplicated in the Chautauqua grape belt, and perhaps in other sections of the State where this fruit is largely grown.

Present conditions in Ohio. The destructive work of this serious pest has been known in Ohio for some years. It was first brought to the attention of Professor Webster in 1893. The similarity of conditions existing between the Ohio grape belt and the Chautauqua region led the entomologist to believe that valuable data could be secured by personally investigating the present status of the insect in Ohio. This interesting section was visited about the middle of September and much valuable information secured through the kindly cooperation of Prof. P. J. Parrott, entomologist of the Ohio Agricultural Experiment Station, Prof. A. F. Burgess, chief San José scale inspector, and a number of prominent growers. The local knowledge of conditions possessed by the two gentlemen named enabled us to

visit the sections of most importance with very little loss of time. Some very precise and significant statements were obtained from Mr T. S. Clymonts of Cleveland O., who is not only a grower but also a dealer and one who undoubtedly has as good a general knowledge of local conditions as any one in that section. He states that in the Ohio belt, extending east and west of Cleveland, from Painsville to Avon and reaching back 5 miles from the lake, there has been a reduction in shipments of fully two thirds during recent years. In 1894 2000 carloads of grapes were shipped from that section. This was reduced in 1900 to 900 and in 1901 to 600. Mr Clymonts estimated the output for the present year as not over 500 carloads.

He states that this reduction is due to various causes, the principal ones being the ravages of the grape root worm, the destruction caused by rot, and the prevailing low prices. He attributes fully one third of the entire reduction to the beetles' work and instanced a number of cases where vineyards of considerable size had been killed by the operations of this pest. He mentioned one vineyard of 60 acres, another of 25 acres, and stated that innumerable small pieces had been destroyed by the work of this insect. He states that the yield of one 60 acre vineyard has been cut from 10–12 carloads to 35–40 tons by its operations. Mr Clymonts observations led him to think that as a rule the younger vineyards, specially those planted in the last 10 or 12 years, suffered most and that the old ones escaped with comparatively little harm. The most destructive work observed by him has been on sandy soil, or on ridges in other pieces. He also states that vines set in an infested vineyard to fill vacancies do not thrive and are usually killed by the insect.

Mr J. W. Maxwell of Euclid states that 50% of the vineyards are dead in that section and that in his opinion a large proportion of these have died as a result of the operations of this insect. His crop of grapes in a large vineyard was reduced fully one fourth, the most of which he attributes to this pest. He states that the Wordens and Brightons are killed first, while the Concords and Catawbas are not so badly injured.

Mr W. H. Slade of East Cleveland estimates that one fourth of the vineyards in that section have been destroyed by this insect pest, and according to his observations the Wordens and Catawbas suffer more than the Concord. The most serious damage in his experience was met with on the lighter soil of knolls.

Mr W. W. Dille of Nottingham is of the opinion that there has been a decrease in recent years of 40% in the area devoted to grapes. He attributes this shrinkage about equally to the rot, which has been very prevalent, to the operations of the grape root worm, and prevailing low prices. He states that the insect injuries have been limited mostly to the bluff and to vineyards in the near vicinity of the lake shore, those back and just under the bluff escaping with comparatively little damage. He considers the Concord as one of the most resistant varieties.

A number of other growers were interviewed and some disparity of opinion naturally prevailed. It will be seen, however, that there are a number of well informed men in that section who attribute very serious injuries to this insect, and while the estimates of some may be excessive, there can be no doubt but that the pest has caused very serious losses. The season of 1902 was unfavorable for observing the work of this pest because the repeated rains have enabled the vines to sustain much greater injury than they would in times when there was less moisture. These conditions prevented the making of personal observations on the destructiveness of the insect and most of our data relating to this had to be obtained from the evidence of others.

Considerable attention was also given to the various remedial measures employed by different growers and some diversity of opinion existed. A number had sprayed their vines with arsenate of lead and also with bordeaux mixture. A few were of the opinion that spraying with arsenate of lead is a very efficient check on the increase of the insect, while others believe that it was of comparatively little value. Mr T. S. Clymonts states that spraying with the bordeaux mixture alone affords

some protection, as the beetles migrate to untreated vines. This subject will be discussed more at length under "Remedial measures." Most of the growers agree that thorough cultivation assists the vines greatly in resisting the depredations of the grubs. The parties on whose premises carbon bisulfid was used were not favorably impressed with the substance. They state that in any event the cost of application is excessive considering the prevailing low prices for grapes. Considerable injury was also inflicted on certain vineyards and it is very doubtful if this measure can be used to advantage.

Early history. This insect was first brought to notice in 1866 when specimens were sent from Kentucky to Mr B. D. Walsh, afterward state entomologist of Illinois. This gentleman stated at the time that he had taken the beetle in small numbers in both north and south Illinois, and later in the same year described the species. He also received the insect the following year from St Louis and Bluffton Mo., where the adults were said to be eating both foliage and fruit. Prof. C. V. Riley, in his first report on the *Injurious and Beneficial Insects of Missouri*, characterizes this species as one of the worst foes to the grapevine in Missouri. This condemnation was based solely on the operations of the beetle on the leaves, an injury which is now regarded as of little importance compared with the work on the roots. Professor Riley received specimens from Bunker Hill Ill., in 1870, and in 1873 Mr G. R. Crotch described the insect under the name of Fidia murina and gave its recorded distribution as from the Middle and Southern states. The identity of the species described by Mr Crotch and this insect was pointed out by Dr Horn in 1892, when he recorded its distribution as from the "Middle States to Dakota, Florida and Texas." He also states that the insect described by Lefevre under the name of Fidia lurida belongs to this species. This pest was received from the vicinity of Iowa City Io., by Prof. H. F. Wickham in 1888, and Professor Riley has recorded this form and the allied F. longipes Melsh. as injuring grape leaves at Vineland Ark.

Nothing further was known regarding this species till 1893 when specimens were sent to Prof. F. M. Webster, then of the Ohio Agricultural Experiment Station, who made an exhaustive study of the insect and published a detailed account of his investigations in 1895.

Injuries by this insect in the state of Arkansas were recorded by Prof. J. T. Stinson in 1896, and in the same year Professor Webster notes a decrease in the numbers of the pest in Ohio vineyards and attributes it as possibly due to the efficient work of two egg parasites and a mite, Heteropus ventricosus Newport. The following year Messrs Webster and Mally reported, as a result of a series of experiments, that tobacco dust and kainit were practically ineffective against this insect, and two years later these gentlemen record the unusual abundance of the pest in Ohio vineyards, and state that serious injuries occurred at Bloomington Ill. The presence of this beetle in destructive numbers in the Chautauqua grape belt was recorded by Prof. M. V. Slingerland in 1900, who at that time published a general compiled account of the insect. Dr J. B. Smith in his *Catalog of the Insects of New Jersey* states that this species occurs throughout New Jersey on the grape and Ampelopsis, and he also records it from Staten island. A brief note published by Dr L. O. Howard last year states that the depredations of this insect at Bloomington Ill. continue unabated and severe damage to vineyards is recorded. The writer, in the early spring, published a brief notice of the extent of the injuries in the Chautauqua grape belt with a summary of the life history of the pest and outlined a series of experiments, which latter are reported on in detail in this bulletin.

DESCRIPTION

The perfect insect is a small, brown, rather robust beetle about $\frac{1}{4}$ inch in length and rather densely covered with short grayish white hairs. It may be recognized by aid of plate 1, figure 1.

The egg is about $\frac{1}{25}$ inch in length and with its transverse diameter about one fourth as great. Form, nearly cylindric,

tapering a trifle at each end. The shell is flexible and when a number of eggs are crowded in a small space their form may become somewhat distorted. The eggs are white when first deposited, but soon assume a yellowish cast. On the fourth day a narrow semitransparent band appears near each end. The eggs of the clusters have a somewhat concentric arrangement and they range in number from 1 to 125. Several clusters are represented on plate 1, figure 4.

The young larva is subcylindric, about $\frac{1}{17}$ inch in length and tapers somewhat posteriorly. The head is a pale, yellowish color with the mouth parts ranging from light to dark brown, the sutures and tips of the mandibles having the most color. The head is somewhat flattened, bilobed and with the posterior angles rounded. The mandibles are distinctly toothed. The body is slightly smaller than the head, convoluted and distinctly segmented. Each segment bears a transverse row of small tubercles, from each of which a long hair arises. The spiracles, or breathing pores, are darker than the body and usually light yellow.

The nearly full grown grub resembles the newly hatched individuals very much in general form and color. It is then about $\frac{5}{8}$ inch in length, with a yellowish brown head and the mouth parts and adjacent sutures dark brown or nearly black. The body has a greater transverse diameter than the head, is distinctly segmented and bears numerous irregular transverse rows of small setae, which are relatively much shorter than in recently hatched individuals. The spiracles are well marked and range in color from yellowish brown to light brown. The general appearance of the grub is shown on plate 1, figure 4.

The pupa ranges in length from about $\frac{1}{4}$ to $\frac{1}{3}$ inch and its general features are represented on plate 1, figure 6. Its characteristics have been minutely described by Professor Webster as follows: "Color, white with pinkish tinge about head, thorax and posterior extremity; head with a semicircular row of four spines, the frontal pair erect, the other two smaller and divergent; near anterior margin of thorax there is a similar row,

likewise placed in the form of a semicircle, while just behind these is a cluster of four smaller and more erect bristles placed in pairs, the anterior of these being the most widely separated. Anterior femora armed at tip with a short, hooked spine, while above and at one side is a single, straight spine terminating in a bristle, posterior femora armed with a stouter hook and two stouter, erect spinular bristles, middle femora unarmed; at posterior extremity are two stout, flattened hooks, whose points extend upward; on the dorsum of the penultimate segment is a row of four distantly placed decumbent spines while on the preceding segment is a median, transverse, closely placed row of four, stout, erect spines, each of the other segments being provided with a single row of minute, short bristles, with two larger ones on the scutellum.

"In the majority of my specimens the anal hooks are as described . . . In some, however, they are bifid, one hook extending upward and the other downward, in which case the spines are much stouter, while beneath are two very short, stubby, hooked appendages. In one specimen one of the anal hooks is bifid and the other simple, and beneath the former is one of the short appendages while there are two of these, closely placed beneath the latter."

LIFE HISTORY

The life history of this insect may be summarized as follows: The winter is passed by the nearly full grown grubs in oval cells in the soil and, so far as our observations go, the great majority of them occur from 10 to 12 inches below the surface and mostly near the subsoil. On the approach of warm weather, the grubs work upward, probably early in May in most years, and may then be found within a few inches of the surface and usually within 15 to 24 inches of the stem of the grapevine. The transformation to the pupa occurs in normal seasons from about June 1 to 20, the adults issuing approximately two weeks later or from about June 20 onward. The great majority of the beetles appear the last of June, though some

do not emerge till much later. A pupa was met with Aug. 15, 1902, and adults have been found in New York vineyards as late as early September. These latter are probably descendants of belated larvae. The eggs are normally laid from the last of June through July under the loose bark of last year's wood and require a period of about two weeks to hatch. The young grubs make little attempt to crawl down the stem and usually fall under the loose soil and make their way to the small feeding roots where under favorable conditions they grow rapidly and after increasing considerably in size, attack the larger roots, eating away long strips of the bark, plate 1, figure 5. The latter, when a large number of grubs are present, may rest simply on a bed of borings. Many of the grubs attain nearly full size the latter part of August or early in September. Late in the fall the larvae descend to considerable depths, as previously noted, construct their oval cells and pass the winter within them.

Habits of the beetle. The habits of the beetle are of special interest because it is possible to collect these insects and thus in a large measure prevent egg laying and consequent damage from the grubs. Professor Webster states that the beetles normally begin to appear in northern Ohio about June 20. This coincides rather closely with our own observations, because most growers agree in considering the season of 1902 remarkably late, and it is therefore not surprising that we met with very few beetles previous to July 2. Their first appearance was on light soil and the insects did not begin to emerge in numbers on heavy land till nearly a week later. The time of appearance and the fact that a large proportion of the insects seem to issue from the ground within a day or two is of much importance, if anything is to be done by collecting the insects. The beetles appear to emerge and remain on the foliage, particularly around buds, several days before they feed to any extent. Breeding cage experiments have fixed this period at from one to four days. Two beetles which actually emerged under observation refused food till the fourth day, and it is very probable

that this period is more nearly the normal time between the emergence of the beetles and feeding. A considerable number may be found before any feeding has taken place, as is evidenced by Mr Barden taking 12 from a vine which bore practically no marks of their eating. The insects may be found in a field over an extended period. Some were observed by Mr T. T. Neill Sep. 4, 1902, in a vineyard at Fredonia.

Oviposition does not occur till some days after the appearance of the perfect insects and according to breeding cage observations this period may range from 10 to 17 days. Our breeding cage experiments also indicate that the insect may feed from 6 to 13 days before eggs are deposited. This period was carefully ascertained by isolating a series of males and females and providing them with as nearly natural conditions as possible. Both of these periods are much longer than normal, since eggs were found by Mr Barden in the Northrop vineyard July 9, where beetles were present in very small numbers on the second. This allows a maximum of only seven days between the appearance of the earliest insects and the deposition of eggs, and, if, as can hardly be questioned, the insects remain without taking food for two or three days, then the time of feeding before the deposition of eggs can hardly exceed an equal period. This matter is of considerable importance because it shows how quickly poisons must act in order to prevent the deposition of any eggs.

The feeding of the beetles occurs almost entirely on the upper surface of the leaves and, as described by Professor Webster, "is done by gathering a quantity of the substance of the leaf in the mandibles and jerking the head upwards, after which the body is moved a step forward and another mouthful of food secured as before. After securing a few mouthfuls in this way they move to another place and begin again, thus eating out numerous chainlike rows of silk net as shown on plates 5 and 1, figure 2. The insects eat only to the lower epidermis on foliage having a velvety under surface, but on others they eat entirely through the leaf." The individuals feeding on the leaves are

easily frightened, and when alarmed usually fold up their legs and fall to the ground, where they remain quiet till all danger appears to have passed. The beetles on the wood, however, are not so easily disturbed. They can frequently be picked from the vine, and it requires repeated jarring to dislodge all. This is of considerable importance when collecting beetles with any machine and the persistence with which some hang to the wood offers a serious obstacle to this method of controlling the insect.

The tendency of this species to remain in a locality is well shown in a certain vineyard at Ripley. It had suffered very severely in earlier years from the depredations of this pest and a portion of it was uprooted last spring. A small area was allowed to remain in the hope that it could be brought back to a normal condition. A few rows next to the uprooted area were fed on to a very great extent by the beetles, which had evidently emerged from the adjacent soil and made their way to the nearest vines where they were content to remain and feed. The extensive injury inflicted on these vines is well illustrated on plate 4, which shows how badly many of the leaves were riddled. A curious fact in connection with the abundance of the beetles on these small vines is that few or no eggs could be found and there is apparently no reason for such a condition. This tendency of the insects to remain in one locality is very favorable to growers attempting to control the pest, as there is less danger of their flying from infested vineyards where no effort is made to check them.

Eggs. The eggs of this insect are deposited almost entirely under the loose bark of last year's wood, many being found as high as the top wire. Professor Webster states that over 700 have been taken from a single vine, and from a section 16 inches in length and an inch in diameter he took 225 eggs. Once he found a few eggs pushed down between the earth and the base of the vine, but we have failed to find eggs in any such position. Beetles in confinement deposited eggs in crevices and cavities of the wood and even on leaves. Eggs were found in the field in 1902 as early as July 9 and oviposition was

still in progress Aug. 15, and though beetles were less abundant than three weeks before, it was still easy to find individuals which contained fully developed eggs. Careful breeding cage experiments were planned to determine the duration of the period of oviposition, the time when the eggs were laid and the total number deposited by a female. A number of pairs of beetles were isolated and provided daily with fresh food. The period of oviposition for a number of confined females was found to extend over a period of 40 days, and in the case of individuals from 7 to 13 days. The records of a few beetles, showing the number of eggs and the size of the clusters in which they were deposited and found, are given herewith.

BEETLE NO. 1

July 11, clusters of 75, 16, 29 and 14 eggs
July 12, a cluster of 33 eggs
July 15, " 20 "
Total, 187 eggs

Some of the clusters recorded for July 11 had been deposited on earlier dates and escaped detection, since they showed the characteristic band near each end, which does not appear for four days.

BEETLE NO. 2

July 13, a cluster of 20 eggs
July 18, " 5 "
July 20, " 25 "
July 21, " 36 "
July 25, " 25 "
July 29, " 30 "
Total, 141 eggs

BEETLE NO. 3

July 11, a cluster of 70 eggs (possibly older than date given)
July 13, " 36 "
Total, 106 eggs

It may be seen by the above records that the beetles deposit clusters of considerable size at intervals of one to three or more

days. The insects which made these records were confined in jelly tumblers, with a small piece of cane and fresh leaves supplied daily. A large number of beetles were also confined in one breeding jar and fed in the same way as the isolated pairs. A careful record of all eggs taken from this large breeding jar was kept and the approximate average for each female was 109. This latter indicates a strong probability of the beetles producing many more eggs under natural conditions. It is manifest that the above were not ideal conditions, and we know that individual adults have an extended existence, some in our breeding cages living and depositing eggs over most of the period from July 3 to Aug. 19. This, in connection with others being taken in vineyards as late as Sep. 5, renders it very probable that females in the field deposit as many eggs, if not a great many more.

Our observations on eggs laid in breeding jars showed that they are deposited in masses of from 1 to 125, the latter being the largest number observed in one cluster. A normal egg mass measures about $\frac{1}{5}$ inch in length and less than one half that in breadth. The somewhat concentric arrangement of the eggs is shown on plate 1, figure 3. The rows of eggs often overlap each other like shingles, and in the center of the mass there is frequently an appearance of two or three layers. The egg clusters are sometimes deposited so that two thirds of the branch is encircled, and in each case the whole mass is covered with a sticky substance, which glues each egg to the other in such a manner that the whole may be easily detached from the vine, as is often the case when a strong wind is blowing.

The duration of the egg stage was determined by repeated observations as from 9 to 12 days (it is stated to be eight days by Professor Webster), about one day being required for an entire mass of eggs to develop after hatching commenced. We were also able to verify Professor Webster's observation on the appearance of a narrow semitransparent band or line near each end of the eggs four days after oviposition. Small numbers of empty egg shells, indicating that hatching had begun, were

found in Mr G. L. Hough's vineyard July 24 and it is very probable that in Mr Clyde Dean's vineyard at Portland, where conditions are about a week earlier, young grubs had appeared some time before.

Habits of the larvae. The young larvae after they hatch from the eggs drop to the ground, as observed by Professor Webster and corroborated in our own experience. There seems to be very little or no attempt on the part of these tiny creatures to crawl down the stalk. A recently hatched grub is such a small creature that it rapidly makes its way into any crevice or crack, and when it drops on loose earth soon disappears from sight. Earlier writers have recommended the covering of the roots of grapevines as deeply practicable at the time the young hatch, so as to present more obstacles to the grubs when making their way to the roots. This suggested to the writer some experiments to determine the burrowing and traveling powers of these little creatures. One small grub was placed on a piece of paper at 9.27 in the morning and its wanderings carefully traced with a pencil till 4.43 in the afternoon. The little creature traveled almost continuously during that entire period and showed a decided tendency to turn to the left. It covered the relatively enormous distance of over 47 feet in seven hours, or an average of about 2 yards an hour. The grub was placed in a dry vial, and under such unfavorable conditions lived about three days. This would seem to indicate that the little creatures can make their way over many obstacles if not confronted by very unfavorable conditions.

Some tests were also planned to ascertain the burrowing powers of these little grubs. A glass tube 17 inches long and ½ inch in diameter was bent so that 4 inches were vertical. It was then filled with loosely packed earth, and on July 29, 40 recently hatched grubs were placed on the surface of the soil in the 4 inch vertical portion. One grub had made its way through the entire mass of soil by July 31, another by Aug. 1, and 11 others by the third, making a total of 14 which had traveled the whole length of this tube in a period of four days.

Another ½ inch tube, 10 inches long with 3½ inches vertical and 6½ inches of its length horizontal was similarly packed and 13 grubs placed on the surface of the soil July 29. Four of these had made their way throughout the entire length of the tube by Aug. 3. Another tube 12 inches long, ½ inch in diameter, with 2½ inches of its length vertical and the remainder horizontal was filled with tightly packed soil and a number of grubs placed in it Aug. 1. On the 7th one grub had made its way through 7½ inches of this tightly packed material. It would seem from the above experiments that while a great many grubs undoubtedly perish in making their way from the vine to the succulent roots on which they feed, they are capable of overcoming great obstacles, and the facts ascertained above at least raise a question as to the advisability of attempting to interpose barriers between the grub and the roots on which it feeds.

The young larvae or grubs are undoubtedly able to exist for some time without food. They soon make their way when possible to the young feeding roots where they may sometimes be found in considerable numbers. The writer, the middle of last August, succeeded in finding eight of these little creatures under a small bunch of feeding roots. They were less than one quarter grown and under larger roots near them several others were found which were about half grown. The occurrence of few half grown larvae and of considerable numbers of nearly full grown individuals the middle of September indicates that these creatures develop very rapidly after they have found suitable roots on which to feed. The finding of a small grub scarcely $\frac{1}{16}$ inch long July 2 indicates that some do not attain their full growth in the fall, since this individual could not have hatched from an egg laid in 1902, as the beetles had hardly begun to appear, and that such individuals must feed to some extent in the spring. It seems probable that these very small grubs produce the beetles which emerge late in the summer, and are therefore responsible for the very extended period during which adults are found abroad. Most of the grubs complete or nearly complete their growth in the early fall, and on the

approach of cold weather descend deeper in the earth. Professor Webster records finding the grubs a foot below the surface in the spring, and our own observations indicate that they descend nearly to that depth where they pass the winter in small oval cells. Their ascent in the spring occurs after the appearance of warm weather and probably some time in early May.

Pupa. Professor Webster records the finding of a very few pupae as early as the first week in June, and Mr Barden states that in 1902 he observed the first pupae at Ripley June 7, though Mr Hough is of the opinion that the larvae began to transform as early as June 4. The great majority of the insects had transformed to this stage by June 23. The pupa cells are almost entirely within 2 or 3 inches of the surface and usually within 2 or 3 feet of the base of the vine.

The duration of the pupa stage has been stated by earlier writers as about a fortnight and actual observations with breeding cage material has enabled us to determine this period as from 13 to 14 days. These observations were made in the office, where temperature conditions were uniform and rather high, and it would not be surprising if this period was materially extended out doors by unusually cold weather.

The oval cells occupied by the larvae can be broken with impunity and the grubs will make others, but such is not true of the pupae. The insect is so delicate in the latter stage that the writer has experienced great difficulty in transmitting them through the mails, even with most careful packing. This is shown by the fact that out of 58 mailed to Albany only 15 arrived alive, a number were carefully packed in their cells or laid on moist cotton, otherwise the fatalities would have been much higher. These facts have a very important bearing on remedial measures, as will be pointed out under that head.

Food plants. This beetle has a comparatively restricted food habit. It was early observed by Mr Walsh on grapevines and the late Professor Riley recorded its feeding on the American redbud, *Cercis canadensis*. It is also known to feed

on the native Virginia creeper, Ampelopsis quinquefolia.

NATURAL ENEMIES

This serious grapevine pest is subject to attack by several natural enemies. Two interesting species of egg parasites, bearing the scientific names Fidiobia flavipes Ashm. and Brachysticha fidiae Ashm. were bred from eggs of this insect by Professor Webster in 1894 and in 1896 he expressed the belief that a marked decrease in numbers of the Fidia was possibly due to the work of these parasites. Professor Webster also observed a small brown ant, Lasius brunneus var. alienus feeding on the eggs, and a small mite, provisionally identified for Professor Webster by Dr George Marx, as Tyroglyphus phylloxerae P. and R., extracting the contents of several eggs in succession, and also a smaller mite resembling Hoplophora arctata Riley. One of these small mites, probably a species of Tyroglyphus, was observed in our breeding cages feeding on the pupae, one being almost entirely destroyed.

Several predaceous insects were found by us during field work, specially when digging for larvae in the early spring. The grubs of some carabid beetle were observed to be about two thirds as numerous as those of Fidia during the last of April and it is very probable that they prey on this species. We were unable to bring any of the carabids to maturity. A small beetle, Staphylinus vulpinus Nordm. was associated with Fidia grubs and possibly preys on them. The larva of an aphis lion, Chrysopa species, was observed by the writer investigating under loose bark where eggs were present, and it is not at all improbable that these insects destroy many.

REMEDIAL MEASURES

It was felt that there was a lack of of definite knowledge regarding methods of controlling this insect when this study was undertaken, and it was accordingly planned to make a thorough test of those advised as well as to experiment along

other lines. Some of these investigations gave results which appear to have a positive value, while others only proved certain measures comparatively useless.

Destroying the pupae. Our finding the pupae of this insect within three inches of the surface of the soil and their great delicacy led Mr Barden to suggest that a certain field be cultivated at a time when the majority of the insects were in the pupal stage. The earth was plowed away from the vines and then turned back, care being taken to get as close to the roots as possible. Investigations in this field in the early part of June resulting in finding from 50 to 60 grubs about many of the vines, while repeated search the latter part of the same month failed to uncover more than three or four insects about a vine and in many cases not a specimen was found. It was too early for the insects to emerge and destruction by cultivation appears to be the most reasonable if not the only way of accounting for their disappearance. This, taken in connection with the great care necessary in handling the pupae, leads us to believe that much can be accomplished by so planning cultural operations that the vineyards will be horse-hoed at the time when the majority of the insects are in the pupa or "turtle" stage. It has been shown on a preceding page that a difference of a week or more may exist in the development of the insect in vineyards within a few miles of each other, and this is probably true of localities even nearer each other. The insects being in the earth are affected by its character and in a warm, light soil emerge earlier than in a heavy one. This difference in the period when the beetles appear renders it necessary for each vineyardist to keep watch of the development of the insects on his own grounds, and plan to do his cultivating at the most favorable time. The pupal stage, as determined by careful experiments, lasts about two weeks, and as the emergence of the beetles extends over a considerable period, it is suggested that the cultivation be delayed till a few of the very early beetles are nearly ready to emerge from the soil. No very serious injury will result if a few actually forsake their pupal

chambers, though if many appear it is probable that the most advantageous time for this work has passed. Plan to plow or cultivate as close to the vines as possible when attempting to destroy the pupae and aim to make the earth fine. It is not necessary to go to a depth of more than 3 inches.

Collecting beetles. This method of controlling the grapevine root worm did not promise much when it was first attempted. Professor Webster had either not considered it worth trying or had found it of comparatively little value, and Dr Marlatt did not even mention it in his recommendations. Professor Slingerland makes the guarded statement that it may be practicable in some cases to jar the beetles into a collecting apparatus, but he apparently had little faith in the plan, except where the beetles could be jarred to the ground where they would be eaten by chickens.

Mr J. J. Barden, working under the writer's directions, found that even with a plain cloth-covered frame several feet square and with a small slit in one side, so that it could be slipped under a vine, that large numbers of the insects could be collected. With this crude apparatus he was able to capture a quart of beetles in about two hours. This indicated that much better results could be secured with a more elaborate apparatus, and with the aid of Mr G. L. Hough he constructed a modified form of the Curculio catcher, which is represented on plate 6. The machine is 6 feet long and 3 feet wide at the top with vertical ends and the sides sloping to a trough about 3 inches square. A central slit about 3 inches wide was cut in the side opposite the handles and the whole mounted on a two wheeled frame. The central trough is subdivided by a few transverse partitions and these spaces are partly filled with kerosene and water. The sides, ends and trough are constructed of galvanized iron and strengthened with iron straps as shown in the figure. The wheels are from a toy cart and the handles and frame are homemade. The method of operation is simply to wheel the machine between the vines and then, elevating the handles, the farther side can be slipped under the wire, and the trunk of the vine

entering the slit permits the placing of the machine directly under the vine. It then remains for the operator to jar the insects off. Mr Barden found that it required several shakings to dislodge all the beetles. In one case he succeeded in catching 64 by jarring a vine once. It was found advantageous to have three machines operating together and placed simultaneously under adjacent vines. This arrangement facilitated the work very greatly and reduced to a minimum the beetles jarred from vines before a machine could be placed under them.

This method appealed so strongly to Mr Hough, who by the way is a very practical business man, that he used it daily for a time on certain badly infested vines and found that in the case of those jarred twice, he did not get over three or four beetles to a vine, whereas at the first operation 40 to 50 were secured and 15 or 20 at the second jarring. An examination in this vineyard July 24 showed that the beetles were not nearly so abundant as two weeks before, probably largely due to the four collectings in the two weeks.

The principal difficulty with the present machine is the relatively large amount of time consumed in placing it under a vine and shaking it two or three times. It would seem possible to devise a practical machine which, while it might not collect as many beetles at any one operation, would catch a considerable number while being dragged, carried or pushed between the vines. This would prevent the delay incident to stopping at every vine, and permit so much more rapid work that a considerable sacrifice in the proportion of beetles captured would be permissible. It would probably require less than one quarter of the time to collect with such a machine, and it is hoped some mechanic will be ingenious enough to make some practical device. The period of about seven days existing between the appearance of the earliest beetles and oviposition would allow considerable collecting before any eggs were deposited.

The late Prof. C. V. Riley, in his report for 1868, calls attention to the fact that one man whose vineyards were very badly infested by this insect had trained his chickens to go between the vines and pick up the beetles as they were dislodged by

jarring. Mr F. A. Morehouse of Ripley, who has many chickens in the near vicinity of his vineyard, has practised the same thing with excellent results. The only trouble is that this method has a comparatively limited application, since it is not always practical to have chickens in large vineyards.

Arsenical poisons. A number of experiments were tried with arsenical poisons for the purpose of ascertaining their efficiency in controlling this species. Two brands of arsenate of lead and paris green were used. Breeding cage experiments with arsenate of lead, using 2 pounds to 50 gallons of water, showed that seven days were required to kill 9 out of 10 beetles, and that when 4 pounds of the poison were used to the same amount of water all of the insects were killed within eight days. The spraying in both instances occurred July 5 and the record is as follows:

2 POUNDS OF ARSENATE OF LEAD TO 50 GALLONS OF WATER

July 7, 6 beetles dead, 3 alive, 1 missing
July 10, another beetle dead
July 11 "
July 12 "

4 POUNDS ARSENATE OF LEAD TO 50 GALLONS OF WATER

July 7, 4 beetles dead
July 9, 4 more dead
July 10, another dead
July 13 "

It will be seen by examining the above records that in the case of the first over half were killed within 48 hours after the spraying, and in the second less than half within 48 hours and four fifths within four days. It should be added that in the above experiments the leaves were sprayed very thoroughly and the poison allowed to dry before the treated foliage was placed in the cage.

The breeding cage experiments with paris green were less successful than those with arsenate of lead, and though in one experiment 20% of the beetles were killed within 48 hours after

spraying the leaves with 1 pound of the poison and 1 pound of lime to 100 gallons of water, and 40% more died within four days after the spraying, the general results were not at all satisfactory and the reason therefor can not be given.

The breeding cage experiments with arsenate of lead would lead one to expect most excellent results in the field, but such was not the case in our own experience, though this may have been due to the fact that the spraying was done shortly before considerable rain fell, and was followed by nearly daily precipitations. The initial application was made July 8 and repeated July 9, the rain of the preceding day making it advisable to go over the entire field a second time. The ground at the time the spraying was done was so wet that it was almost impossible to drive a team slowly enough to do good work. Careful search in the vineyard eight days after failed to reveal a single dead beetle. July 31 there were plenty of beetles and many eggs in Mr Northrop's vineyard where the vines had been sprayed. The necessity of two sprayings resulted in the application of considerable poison, and about five weeks after the treatment it was seen that the sprayed vines had developed very little new growth as compared with untreated ones. There was no perceptible burning, yet the edges of the leaves were somewhat crumpled and it is very probable that the poison checked the development of the more tender shoots.

The evidence concerning the efficacy of poisons in Ohio, as pointed out on a preceding page, is somewhat contradictory. Reporting on work done in 1899, Professor Webster states that an examination of sprayed fields showed nothing to indicate that arsenate of lead would not prove entirely effective. This differs from some later experiments performed under his direction by Messrs Newell and Burgess the unpublished records of which, through the kindness of Prof. P. J. Parrott, have been placed at my disposal. The summary of this later work is as follows: "Where beetles were abundant last year and vines seemingly badly injured and the arsenate of lead or disparene used this year (1900) few vines have died and all appear

in a more healthy condition, but this is true also where none of these insecticides were used, beetles appearing later and in less numbers than for several years." Professor Webster, at the writer's request, has commented on the above experiments as follows. He states that early results though satisfactory were not thought by him to be conclusive and that a marked decrease in the number of the beetles, vitiated later experiments to some extent, so that he did not consider them as either conclusive in themselves or as disproving the earlier work of Mr Mally. He states that arsenate of lead must be tried thoroughly several times where conditions are such as to enable one to obtain decisive results either one way or the other before it will be safe to make definite statements. Professor Stinson reports only fair success in destroying the beetles with poisons in Arkansas.

It seems very probable, therefore, that some of the Ohio growers have been led to attribute the relative scarcity of these beetles to the use of poison whereas it may have been due almost entirely to natural conditions.

The beetles apparently ate the poisoned foliage almost as readily as the unpoisoned in our breeding cages, and nearly the same results are reported by Professor Mally. They are voracious eaters and it would therefore seem as though they would be amenable to this treatment, provided the insecticide is on the vines at the time the beetles appear. Even if they are not killed in the first three or four days, our studies of the egg-laying habits show that if the adults are not destroyed for a week or more, they would be prevented from depositing a large proportion of their normal quota of eggs.

The evidence at hand is altogether too little to warrant the statement that poisons are of little value against this insect, but it seems probable that these substances will be found efficacious only when they are applied most thoroughly and under favorable conditions. We can not under present conditions feel the confidence of some earlier writers in poison sprays for this insect.

Mr T. S. Clymonts states that in his experience spraying with bordeaux mixture has proved of some benefit, since the beetles

prefer untreated vines and will migrate to them if nearby. It may be that this very efficient fungicide could be used with even greater benefit if a moderate amount of arsenate of lead were added to it. This combined insecticide and fungicide we hope to test another season.

Pulverizing the soil and mounding. Prof. F. M. Webster, as a result of his studies, advised thorough cultivation of the soil during the hatching period, taking special pains to keep it banked up over the roots. Professor Webster's idea was that the young insects dropping in the dry sand would be quickly destroyed wherever exposed to the sun, that the looseness of the surface layers would prove a serious hindrance to their burrowing, and that the increased depth over the roots would also provide an additional barrier to the grubs. Thorough cultivation is undoubtedly a most excellent thing and the additional vigor arising therefrom is a valuable asset in enabling the vine to withstand very serious injury. Our experiments on the traveling and burrowing powers of these little grubs, however, lead us to believe that this measure, so far as preventing access to the roots is concerned, is not of much value. This is confirmed somewhat by the experience of Mr T. S. Clymonts, who states that a seriously injured vineyard can be renewed by thorough cultivation, and that he has experienced no difficulty in doing this with flat cultivation. In fact Mr Clymonts is of the opinion that mounding the earth about the vines is injurious in other ways and therefore does not advise it. He recommends cutting back the vines to the living wood, enriching the land liberally with stable manure and applying about a barrel of salt to the acre. Then he cultivates with a disk harrow or other tool which will not stir the earth to a great depth, since he believes that deep plowing cuts off a large number of roots and is very injurious to the vines. He states that in several cases known to him where this has been done and flat culture adhered to, badly damaged vineyards have been restored to a very satisfactory condition.

Carbon bisulfid. Prof. F. M. Webster instituted some rather

extensive experiments with carbon bisulfid against this insect and the summary of his results are as follows. He found that the substance could not be used to advantage in soil that was very dry or saturated with water, and that it must be used in that which is damp. He states that the most satisfactory results will probably follow its use in the spring, in a damp soil, when it is applied in such a manner as to fumigate the roots without the fluid coming in contact with them. He recommends from 4 to 6 ounces for each vine and states that it is not possible to kill every worm about each vine, and that it is doubtful if the low price then current for fruit would justify its use. Growers in the vicinity of Cleveland have not used this insecticide to any extent since the time Professor Webster made his experiments, and they give the high cost as the reason for its not being adopted. It should also be added that considerable care is necessary or the vines will be severely injured.

Kerosene emulsion. Several writers have advised killing the grubs at the base of the vines by the use of a kerosene emulsion, which is to be washed to a greater depth by copious watering or subsequent rain. We have seen very few cases where the grubs were congregated sufficiently to warrant any attempt at killing them in this manner and it hardly appears practical in a large vineyard.

Crude petroleum. It was hoped that it would be possible to destroy the grubs of this pest by the application of this substance to the soil, and there seemed a chance of using it to prevent the young larve making their way to the roots. Some experiments in the office, however, demonstrated that the grubs easily penetrated soil which had the surface layers moistened by a fine spray of the oil, specially if placed on the soil 30 minutes to half a day or more after treatment. This substance appears to have very little value in controlling this insect.

Effect of calcium carbid refuse on grubs. Our attention was called to this substance by the statement that it had proved very valuable against the Phylloxera in France. Some of the material was kindly sent us from the Union Carbide Company's

plant at Niagara Falls and various experiments with the grubs were tried. One part of this substance mixed with 10 pounds of soil was placed in a box and some grubs added. One was dead the next day after having burrowed about ¼ inch and two others went to the depth respectively of 1¼ and 2 inches. No additional fatalities occurred even after 10 days. Several other experiments gave the same general results and apparently we can have no hopes of this substance being of value in this particular case.

Recommendations. Apparently no one method can be relied on to control this insect and our recommendations may be summarized as follows: Plan cultural operations so that horse hoeing from the vines or other cultivation will occur when the great majority of the insects are in the pupal stage and take special pains to thoroughly disturb the soil in the near vicinity of the stem. Thorough cultivation and well enriched soil will do much in aiding the vines to withstand attack. This, supplemented by collecting beetles, particularly if a device can be made which will catch them without the delay incident to stopping at each vine, is advisable on badly infested areas during the first week or 10 days after the adult insects appear. The latter may be supplemented or replaced by thorough spraying with an arsenical poison, preferably arsenate of lead, when the beetles begin to appear. Evidence at hand is rather condemnatory of spraying in the field, but laboratory results indicate that it should be thoroughly successful, and later experiments may demonstrate this to be the case.

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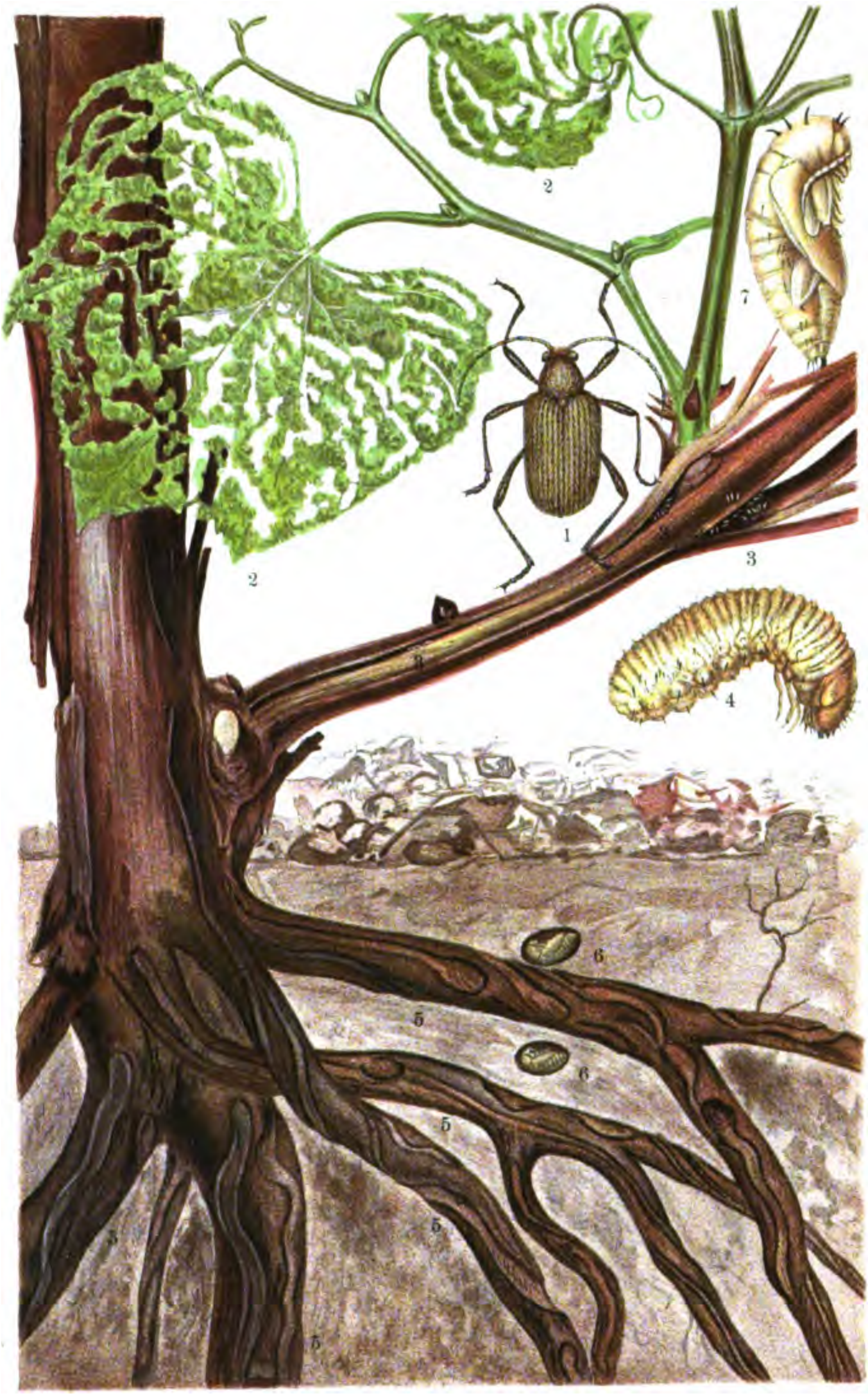

L. H. Joutel, 1902

Grapevine root worm

Photo Aug. 15, 1902

Vineyard badly injured by grapevine root worm (The vines should cover the wires and posts.)

Photo Aug. 15, 1902

Vineyard very badly injured by grapevine root worm (Most of this piece was torn out by the owner as worthless.)

Plate 4

Photo Aug. 15, 1902

Foliage badly eaten by beetles

Leaves from badly eaten vine, illustrating the peculiar chainlike eroded areas

Photo Aug. 15, 1902

Beetle catcher

EXPLANATION OF PLATES

Plate 1[1]

Fig.

1 Beetle, much enlarged

2 Leaf badly riddled by the beetle

3 Eggs on last year's wood, the loose bark has been lifted so as to expose them.

4 Larva or grub, much enlarged

5 Work of larva or grub on larger roots

6 Pupa or "turtle stage" in cell

7 Same much enlarged

Plate 2

Vineyard badly injured by the grapevine root worm. Observe that very few of the vines extend to the top wire. The wires and posts would ordinarily be concealed in a thrifty vineyard.

Plate 3

Vineyard more seriously infested than the preceding. A portion of this was uprooted last spring, and the area shown was kept simply for experimental purposes.

Plate 4

Portion of two vines represented on the preceding plate and showing how badly the beetles may eat the foliage when abundant.

Plate 5

Leaves from badly eaten vine, illustrating the peculiar, chain-like eaten areas.

Plate 6

Beetle catcher devised by Messrs Hough and Barden.

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[1] Executed from nature under the author's direction by L. H. Joutel.

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Museum annual reports 1847–date. *All in print to 1892, 50c a volume, 75c in cloth; 1892–date, 75c, cloth.*

These reports are made up of the reports of the director, geologist, paleontologist, botanist and entomologist, and museum bulletins and memoirs, issued as advance sections of the reports.

Geologist's annual reports 1881–date. Rep'ts 1, 3-13, 17–date, O.; 2, 14–16, Q.

The annual reports of the early natural history survey, 1836-42 are out of print.

Reports 1-4, 1881-84 were published only in separate form. Of the 5th report 4 pages were reprinted in the 39th museum report, and a supplement to the 6th report was included in the 40th museum report. The 7th and subsequent reports are included in the 41st and following museum reports, except that certain lithographic plates in the 11th report (1891), 13th (1893) are omitted from the 45th and 47th museum reports.

Separate volumes of the following only are available.

Report	*Price*	*Report*	*Price*	*Report*	*Price*
12 (1892)	$.50	16	$1	19	$.40
14	.75	17	.75	20	.50
15	1	18	.75		

In 1898 the paleontologic work of the State was made distinct from the geologic and will hereafter be reported separately.

Paleontologist's annual reports 1899–date.

See fourth note under Geologist's annual reports.

Bound also with museum reports of which they form a part. Reports for 1899 and 1900 may be had for 20c each. Beginning with 1901 these reports will be issued as bulletins.

Botanist's annual reports 1869–date.

Bound also with museum reports 22–date of which they form a part; the first botanist's report appeared in the 22d museum report and is numbered 22.

Reports 22-41, 48, 49, 50 and 52 (Museum bulletin 25) are out of print; 42-47 are inaccessible. Report 51 may be had for 40c; 53 for 20c; 54 for 50c. Beginning with 1901 these reports will be issued as bulletins.

Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have been published in volumes 1 and 3 of the 48th museum report and in volume 1 of the 49th, 51st and 52d reports. The botanical part of the 51st is available also in separate form. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged, and combined with others more recently prepared and constitute Museum memoir 4.

Entomologist's annual reports on the injurious and other insects of the State of New York 1882–date.

Bound also with museum reports of which they form a part. Beginning with 1898 these reports have been issued as bulletins. Reports 3-4 are out of print, other reports with prices are:

Report	*Price*	*Report*	*Price*	*Report*	*Price*
1	$.50	8	$.25	13	$.10
2	.30	9	.25	14 (Mus. bul. 23)	.20
5	.25	10	.35	15 (" 31)	.15
6	.15	11	.25	16 (" 36)	.25
7	.20	12	.25	17 (" 53)	.30

Reports 2, 8-12 may also be obtained bound separately in cloth at 25c in addition to the price given above.

Museum bulletins 1887–date. O. *To advance subscribers, $2 a year or 50c a year for those of any one division :* (1) *geology, including economic geology, general zoology, archeology and mineralogy,* (2) *paleontology,* (3) *botany,* (4) *entomology.*

Bulletins are also found with the annual reports of the museum as follows:

Bulletins	*Report*	*Bulletins*	*Report*	*Bulletins*	*Report*
12–15	48, v. 1	20–25	52, v. 1	35–36	54, v. 2
16–17	50 "	26–31	53 "	37–44	" v. 3
18–19	51 "	32–34	54 "	45–48	" v. 4

The letter and figure in parenthesis after the bulletin number indicate the division and series number. G=geology, EG=economic geology, Z=general zoology, A=archeology, M=mineralogy, P=paleontology, B=botany, E=entomology, Misc=miscellaneous.

Volume 1. *6 nos. $1.50 in cloth*

1 (Z1) Marshall, W: B. Preliminary List of New York Unionidae. 20p. Mar. 1892. *5c.*

2 (B1) Peck, C: H. Contributions to the Botany of the State of New York. 66p. 2pl. May 1887. [*35c*]

3 (EG1) Smock, J: C. Building Stone in the State of New York. 152p. Mar. 1888. *Out of print.*

4 (M1) Nason, F. L. Some New York Minerals and their Localities. 20p. 1pl. Aug. 1888. *5c.*

5 (E1) Lintner, J. A. White Grub of the May Beetle. 32p. il. Nov. 1888. *10c.*

6 (E2) ——— Cut-worms. 36p. il. Nov. 1888. *10c.*

Volume 2. *4 nos.* [*$1.50*] *in cloth*

7 (EG2) Smock, J: C. First Report on the Iron Mines and Iron Ore Districts in New York. 6+70p. map. June 1889. *Out of print.*

8 (B2) Peck, C: H. Boleti of the United States. 96p. Sep. 1889. [*50c*]

9 (Z2) Marshall, W: B. Beaks of Unionidae Inhabiting the Vicinity of Albany, N. Y. 24p. 1pl. Aug. 1890. *10c.*

10 (EG3) Smock, J: C. Building Stone in New York. 210p. map. tab. Sep. 1890. *40c.*

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11 (EG4) Merrill, F: J. H. Salt and Gypsum Industries in New York. 92p. 12pl. 2 maps, 11 tab. Ap. 1893. *40c.*

12 (EG5) Ries, Heinrich. Clay Industries of New York. 174p. 2pl. map. Mar. 1895. *30c.*

13 (E3) Lintner, J. A. Some Destructive Insects of New York State; San José Scale. 54p. 7pl. Ap. 1895. *15c.*

14 (G1) Kemp, J. F. Geology of Moriah and Westport Townships, Essex Co. N. Y., with notes on the iron mines. 38p. 7pl. 2 maps. Sep. 1895. *10c.*

15 (EG6) Merrill, F: J. H. Mineral Resources of New York. 224p. 2 maps. Sep. 1895. *40c.*

Volume 4

16 (A1) Beauchamp, W: M. Aboriginal Chipped Stone Implements of New York. 86p. 23pl. Oct. 1897. *25c.*

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Volume 5

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25 (B3) Peck, C: H. Report of the State Botanist 1898. 76p. 5pl. Oct. 1899. *Out of print.*

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2 Hall, James & Clarke, J: M. Paleozoic Reticulate Sponges. 350p. il. 70pl. Oct. 1899. *$1, cloth.*

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